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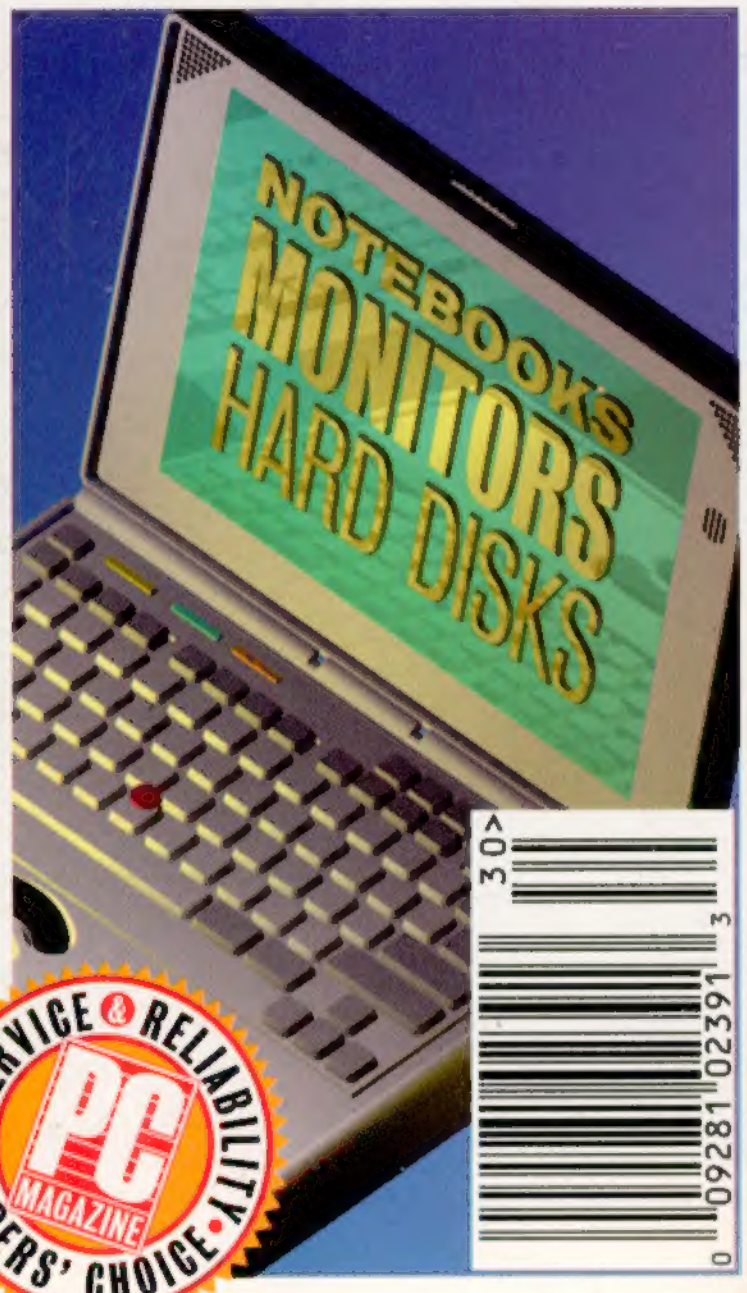

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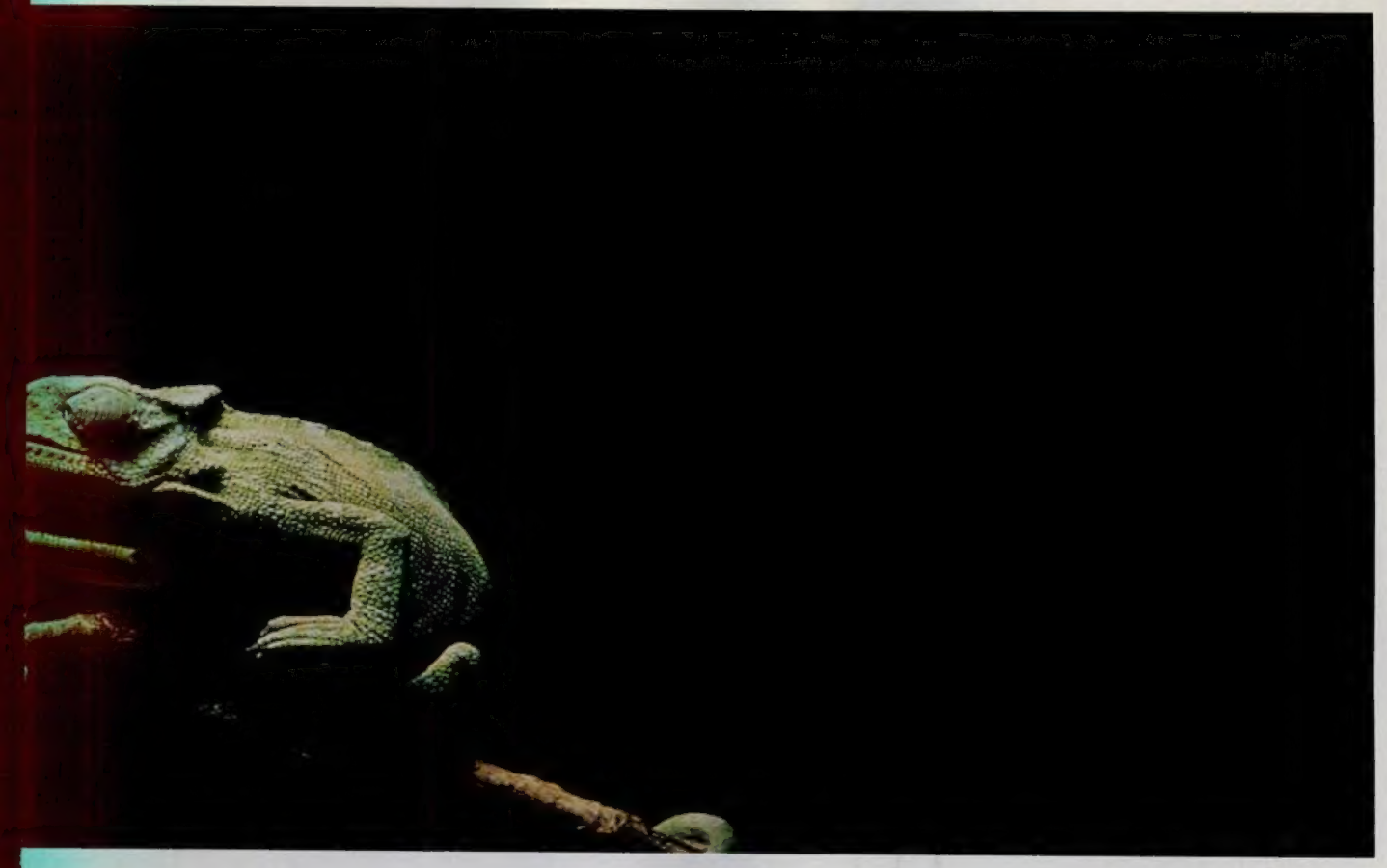

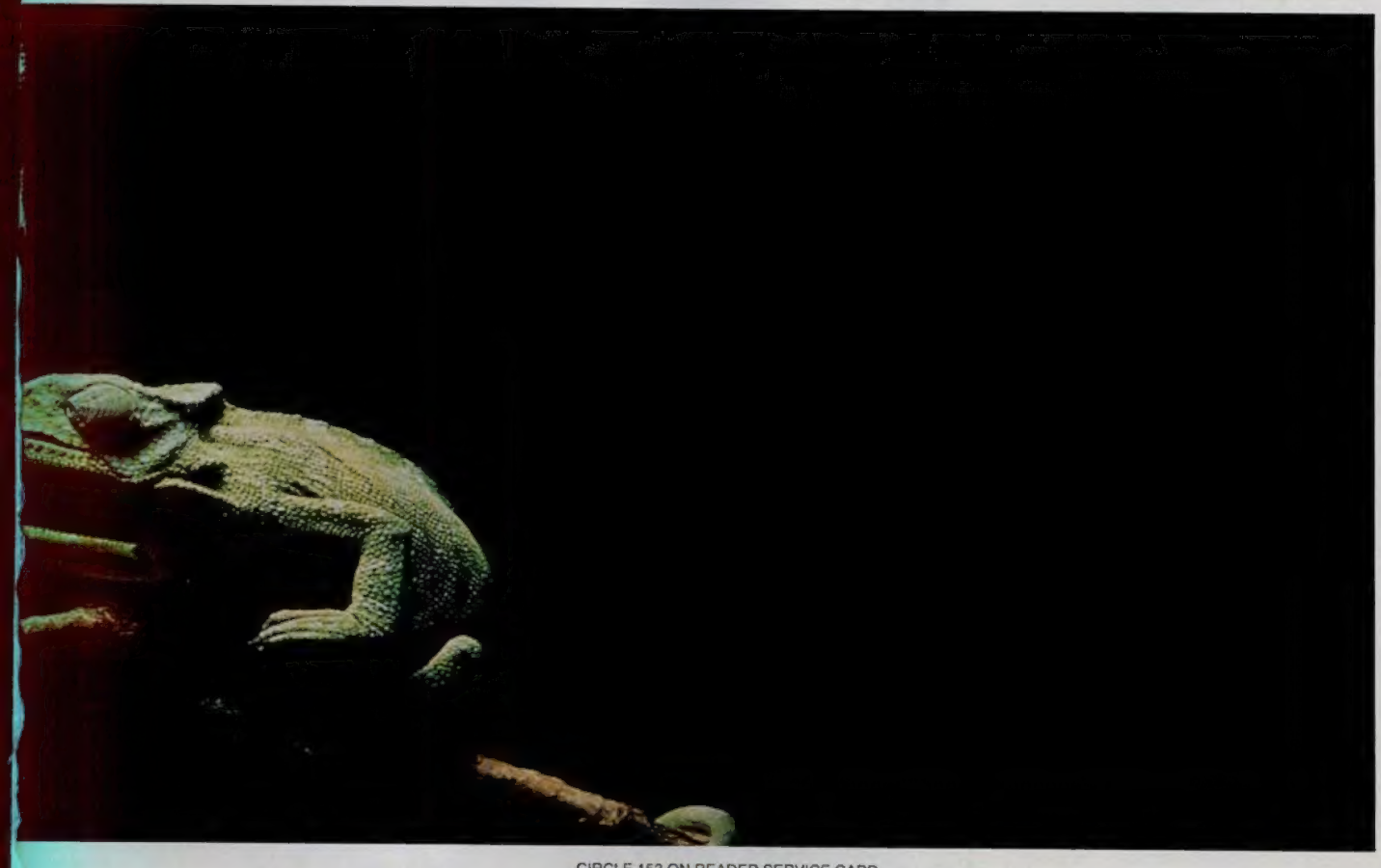

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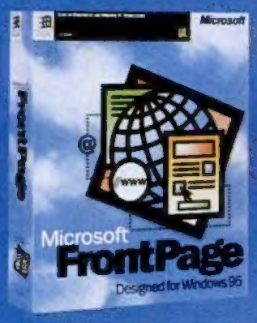

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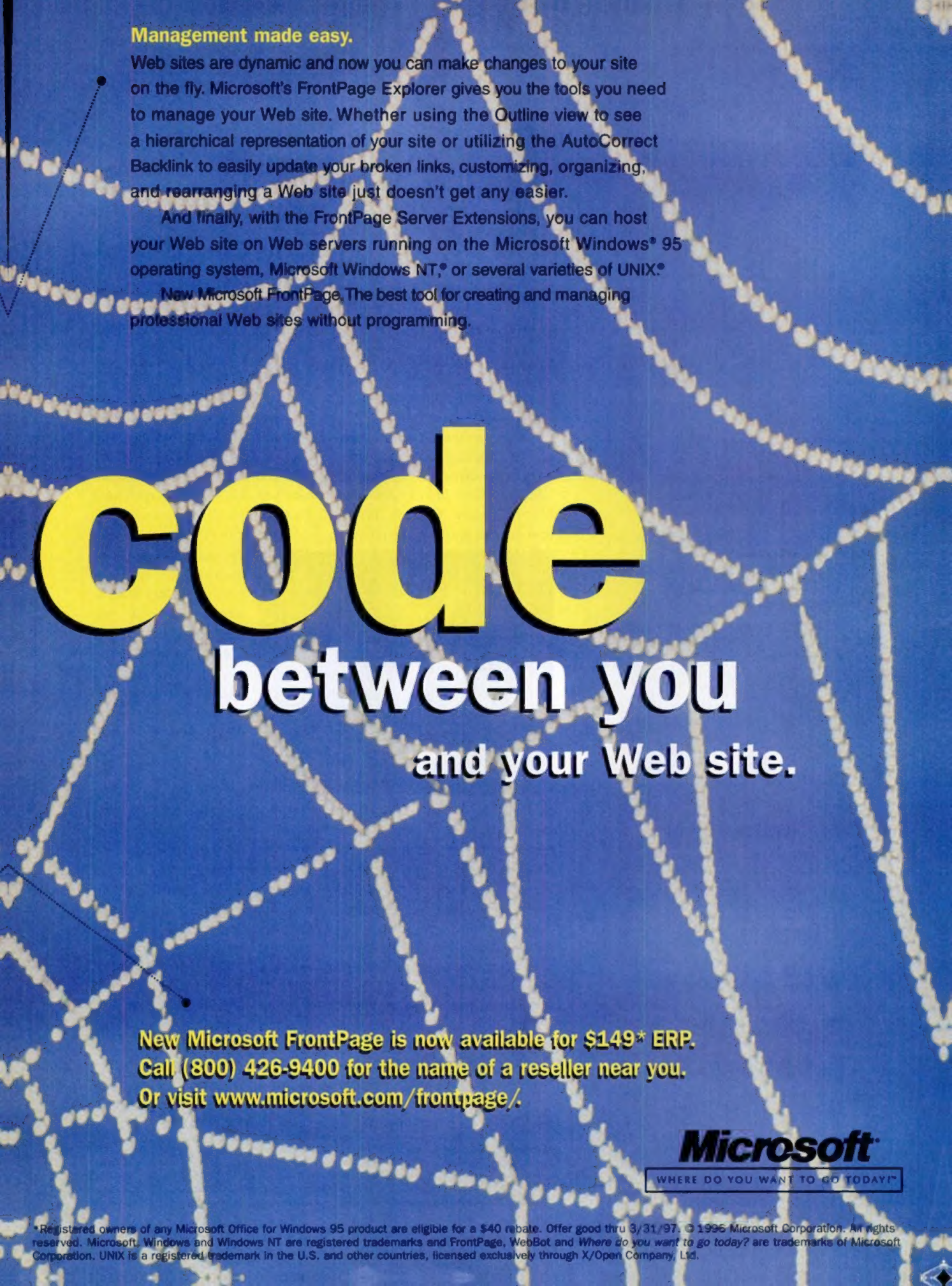
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Inside

As you browse through this issue, the first thing that will strike your eye is the dozens of illustrations showing different versions of the Perfect PC, the Perfect Components, and the Perfect Connections. Such drawings may look simple, but they are actually among our most complicated annual undertakings.

Work on these drawings begins in February each year, when a team of editors and Labs staff, headed by executive editor Bill Howard, starts to flesh out the specific categories we're going to want illustrated. In many cases, we are faced with a number of questions on specific technology decisions. Our project leaders, technical analysts, and support technicians head into PC Magazine Labs, where for several months they test various combinations of machines, components, and software—examining how the various interactions affect performance and reliability.

The Labs staff and our editors then meet to decide what to illustrate, so that our associate editors and staff editors can begin compiling the instructions, the lists of features, and, in many cases, the sketches and photo samples that form the technical bases for the illustrations.

For the Perfect PC issue, art director Laura Baer (center) and her staff really get into their work.

For the third year in a row, the major illustrations themselves are the product of Jack Harris, whose detailed eye continues to amaze. Under the supervision of our art director, Laura Baer, Jack's initial versions are pored over by our editors and Labs staff, who ensure the drawings are as accurate and up to date as possible.

At the same time, our editors and art directors responsible for the PC Magazine CD and for PC Magazine Online review the illustrations and work with Jack to come up with compelling versions for their respective media. Check out the CD or visit our Web site (*http://www.pcmag.com*) to see how new technology changes the way you look at the art.

As usual for *PC Magazine*, it's a team effort—one we hope helps you find the PC that's perfect for you.—*Michael J. Miller*

PHOTOGRAPH BY MARY E. BEHR, ILLUSTRATION BY JACK HARRIS/VISUAL LOGIC

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COVER ART BY VISUAL LOGIC/JACK HARRIS

COVER STORY

THE PERFECT PC

ILLUSTRATIONS BY VISUAL LOGIC/JACK HARRIS AND JOE STRZYKALSKI

BY MICHAEL J. MILLER How do we define the Perfect PC? Here at *PC Magazine,* we believe there's no one definition that fits everyone's computing needs. That's why, in this issue, we present our view of nine variations on this theme—from the no-holds-barred dream machine to the desktop-replacement portable system to the perfect home PC (including home-office and gamer upgrades) and the application server. We explain existing as well as up-and-coming technologies and point out the features and functions you should look for when you are planning to outfit your Perfect PC.....**101**

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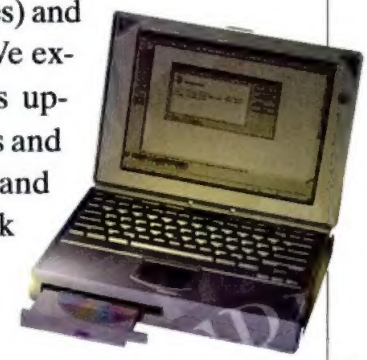

Special Pullout Section

How to Buy the Perfect PC

Before you purchase your PC, take a look at this special section. We include advice on where to shop and what to buy, the Ultimate Upgrade Guide to help you decide when and what to upgrade, and suggestions on the best ways to use an extra $300 to improve your new PC. You'll also get tips on how to squeeze that last ounce of performance from your current system **121**

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COVER STORY

THE PERFECT Components

In this section, we look at the components that come with the Perfect PC. Our coverage starts inside as we consider the perfect processor, memory, and motherboard. Then we look at the components that make up each major subsystem and examine the various peripheral-bus options that are here now or will be here soon. We also help you pick the best graphics accelerator and monitor to fit your needs—whether you are a business user or graphics pro. After an overview of hard disks and removable storage options to help you find better ways to store your data, we visit the perfect multimedia components.....**134**

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BY FRANK J. DERFLER, JR. It has never been easy, but now building and managing the perfect network are becoming even more complex. While network users demand Internet access—and intranet tools provide new ways to share information—network managers must still confront traditional network design and management problems. In this section, we cover trends related to Internet access and intranets, as well as mainstream networking topics such as remote access, fast networking, switching, routing, and network operating systems.....**182**

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▲ ABOVE AVERAGE
○ AVERAGE
▼ BELOW AVERAGE

Vendor (# of responses)
DESKTOP
Acer/Altos (485)
ALR (110)
Apple/Macintosh (593)
AST (612)
AT&T/NCR (298)
Austin/IPC (92)

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BY LANCE ULANOFF AND RACHEL DERBY TEITLER Our subscribers assess how much they like their software and its technical support. We also talk to a few readers who comment on their experiences with software.....**227**

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SERVICE & RELIABILITY • PC MAGAZINE • READERS' CHOICE

Industry Scorecard

The PC Magazine Top 150 Companies

The Top 150 Companies—*PC Magazine*'s annual guide to the leading PC, server, peripheral, networking, and software vendors—reveals who thrived and who survived a tumultuous 1995 in the PC industry. It's a must for serious buyers.....**249**

16	Leading Edge Products Inc. (acquired by Manuhold Investment AG)	Westborough, MA; 508-562-3322	None	$295	10
17	Texas Instruments Inc., Personal Productivity Products	Temple, Texas; 800-848-3927, 817-771-5856	www.ti.com	$230	91
18	Power Computing Corp.	Round Rock, Texas;	www.powerc.com	$209	63

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Piece together the shattered sword and defeat the evil wizard (page 460).

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What's New Online

Where in the Wide World Web are people going? To help give our readers a sense of where their fellow Web travelers go most often, we've enlisted the help of Web 21 (*http://www.web21.com*). Web 21 lists the Web sites visited most often within the past week based on its analysis of Web traffic—hits aggregated from a variety of sources including surveys, logs, and traffic samples. Our Hot 25 is the short list of the 25 hottest—or most frequently visited—sites on the Web, annotated by the editors of PC Magazine Online.

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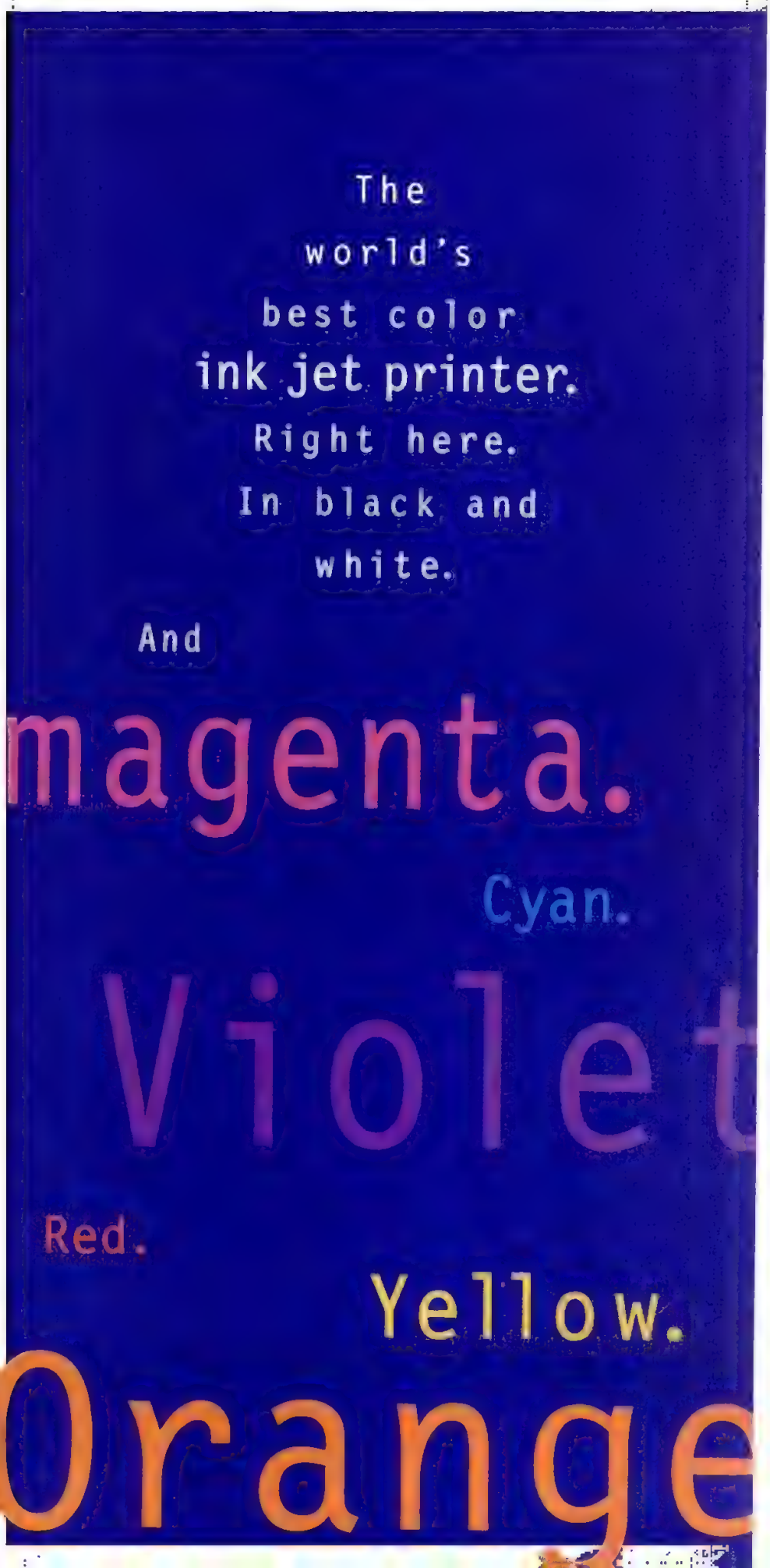

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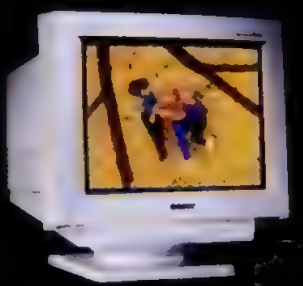

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Letters

ME AND MY BROWSER

I found your March 12, 1996, cover story, "Better Ways to Browse the Web," to be well done and welcome for novice Websters. As usual, *PC Magazine* approached the subject with a comprehensive overview of product offerings and useful tutorials concerning the nuts and bolts of Internet communication.

GARY ENOS
Macedonia, Ohio

What an interesting article. I have a few comments to add regarding Microsoft's Internet Explorer. I find the concept of package installation to be excellent; other software vendors should do the same. Mail integration makes life easier when sending an HTML document and best of all, integration with Word 7.0 allows me to edit a World Wide Web page on the fly. As for Lotus Notes, I have yet to see the richness in document management—like the ability to handle hypertext and .OLE as well as a global search engine.

DOC PISAPATI
via the Internet

Your article on browsers was very good, but you ignored e-mail editors. What I really want built into my browser is an integrated word processor, an e-mail programmer with full editing features, a macro-recorder, and the ability to attach files to any internal or external e-mail system. What don't I want? A proprietary system with peculiar file formats for my URL and address book files, and an e-mail program with primitive editing features.

BILL COPENHAVEN
via the Internet

Your article on Web browsers was timely and informative but didn't hit the mark 100 percent of the time. What would have interested me most was not a look at multimedia features, but a comparison of the speeds of those browsers. You did indicate the speeds of IBM's Web Explorer and Netscape Navigator, but what about the rest of them?

MARK G. DAVIS
via PC MagNet

Your browser's capabilities are only as good as the capabilities of your Internet connection. If you don't get everything the browser may be capable of handling, it may not be the fault of the browser or your system.

MARILYNN LARKIN
via the Internet

I have to object to your naming Netscape Navigator, Version 2.0, as an Editors' Choice. Though I agree that Netscape is clearly leading browser development, the "final" release is not really for serious use. I have run every

Your article on browsers was very good, but what I really want is....

release of Netscape since Version 0.9, and the current release seems no more stable than beta 6 and significantly less stable than Version 1.22. Netscape may be leading development, but this release seems to have sacrificed reliability for new functionality.

FRANK LARIMER
Clinton, Tennessee

I cannot help but notice a major omission in your list of top-notch browsers. Internetworks, now known as GNNworks, is more robust and powerful than earlier releases. On a feature-by-feature basis, it stacks up very well against Netscape Navigator.

JORGE MOSTACCERO
via the Internet

LEARNING NEW TRICKS

In recent months your magazine seems to be making an effort to include articles and software reviews of operating systems other than Windows. I applaud these efforts, but this means your journalists will need to develop competencies with these other operating systems in order to write intelligent reviews.

ROBERT MEYER
via the Internet

I CAN READ WITH MY EYES SHUT

I enjoyed reading Bill Machrone's column "Can Your PC Help You Read Faster?" (March 12, 1996), but this time he has swallowed a fallacy—hook, line, and sinker. Do a Web search on Ron Carver, the academic who debunked Evelyn Wood's speed-reading method. You'll find that what speed readers actually do is skim and boldly infer meaning; mastery of that dubious skill, plus a few pointers on study method and note taking, is what Evelyn Wood charges a lot of money for. The PC can be a powerful tool for remedial and developmental reading.

TOM LEARMONT
South Africa

CLOSET SPACE

I enjoyed your articles on removable mass storage ("Endless Storage," March 12, 1996). But one point that I've never seen addressed in any article on tape drives is the dependability of tape as a storage media. Maybe I've just had unusually bad luck, but most tapes I've used are not only very slow, they are unreliable as well. Most of my cartridges had to be replaced and discarded within 18 months because the header became unreadable even after reformatting.

JOHN M. CANIPE
Asheboro, North Carolina

Let me get this straight: The SyQuest EZ135 drive costs just a little more than the Iomega Zip drive, its cartridges have greater capacity, it's much faster and twice as reliable, and it comes with drivers for Windows NT and OS/2. So tell me again how it is they both rate an Editors' Choice. It seems clear there should be only one.

JIM MORGAN
via PC MagNet

INFORMATION JUST FOR KIDS?

I was very happy to see your At Home roundup "Multimedia Encyclopedias: Just the Facts?" (March 26, 1996). Last year I bought the new Grolier Encyclopedia, Encarta, and Microsoft Bookshelf, but I found the text to be too shallow. It's very nice for children to be able to see video clips of Churchill lifting his hat, but I need an encyclopedia for adults.

VRATISLAV RICHARD EUGÈNE MARIA JOHN BAPTISTE
Czech Republic

I was shocked when Microsoft Encarta 96 received a thumbs down in your recent article. As a ninth-grade student, I've used many CD-ROM–based encyclopedias, and I find that Microsoft Encarta 96 is not only easy to use but fun. You may think that a video clip of modern dance or basketball is unnecessary, but features such as these enhance its appeal to kids and make doing research fun.

PAUL MAIDMAN
Montvale, New Jersey

STIRRING UP TROUBLE

John C. Dvorak's column "In the Wake of Windows 95" (March 26, 1996) appears to stir controversy with a "let's see how this goes" attitude. He asserts that Microsoft's prerelease

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Letters

practices are to blame for the collapse in stock price for several major software companies. What he fails to mention is that these companies have become major as a result of Microsoft's success with Windows, and that customers will wait and see because Microsoft has a history of offering superior products that are worth waiting for.

BOB COOK
via PC MagNet

Until I read Dvorak's reality-check article on Windows 95, I thought that I was one of the very few who unloaded Windows 95 from both my notebook and my kids' desktop. After numerous unexplained freeze-ups and incompatibilities with the kids' favorite CD-ROMs and programs, I had enough. We are now cruising happily and crash-free with PC-DOS 7.0. After six months and many hundreds of dollars spent on hardware and software upgrades, we're back to where we started.

ARI J. ROCKLIN
via PC MagNet

GOOD BUT SLOW

Concerning "SuperPrint 4.0: The 32-Bit Printing Alternative" (First Looks, March 26, 1996): SuperPrint does a good job of rendering accurate gray-scale representations of color, but I find it to be very slow. An Excel spreadsheet that takes 6 seconds to print under Windows 95 using the standard driver takes approximately 100 seconds to print using SuperPrint.

JOE WARREN
via the Internet

HOW TO CONTACT US

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CORRECTIONS AND AMPLIFICATIONS

In our May 28, 1996, story "Beyond The Pentium," the sidebar titled "First Cyrix 6x86 PCs: How Good? How Fast?" inadvertently left out company contact information for the following:

- Magitronic Technology Inc., Norcross, Georgia; 800-731-5611, 770-849-0667; fax, 770-441-2874.
- Micro Express, Irvine, California; 800-989-9900, 714-852-1400; fax, 714-852-1225.
- SPImicroelectronics, Williston, Vermont; 800-495-8355, 802-864-8555; fax , 802-864-5158.
- Sys Technology Inc., Cypress, California; 800-613-9963, 714-821-3900; fax, 714-821-9592; *http://www.systechnology.com.*

In our May 14 cover story, "The Ultimate Utility Guide," the section on diagnostic utilities listed incorrect Web addresses for two of the companies. For more information on Quarterdeck's WinProbe 4, visit *http//www.quarterdeck.com.* For more on Touchstone Software's WinCheckIt utility, visit *http//www.checkit.com.*

COMINGS AND GOINGS

I very much enjoyed reading the Inside OS/2 column "Exploring the OS/2 CONFIG.SYS File" (March 12, 1996). I also appreciated the recent reviews of commercially available OS/2 products. I purchased Stardock's Object Desktop based on the First Looks review (February 6, 1996). In fact, your past few issues have shown a marked increase in coverage of OS/2-based material. Where appropriate, you have even run sidebars highlighting OS/2 alternatives to the products reviewed. Consider my subscription renewed.

JEFF ASIK
Charlotte, North Carolina

I've decided not to renew my subscription. As a user of OS/2 Warp, I find very little useful information in *PC Magazine*, though I do realize that OS/2-related coverage has been increasing lately. One or two OS/2-specific articles or reviews per month, however, is not enough for me.

JIMMY SHAW
via the Internet

LOOKING TO THE FUTURE

Your April 9, 1996, cover story, "Create Your Own CD: CD-R Drives," did a good job of covering a difficult subject, but I found the presentation to be too wordy and the graphics misleading. In the future, closer scrutiny to claims with a view toward fairness and graphs that more accurately reflect what you are trying to convey would be helpful.

KEN APPLEGATE
Valley Forge, Pennsylvania

As your article clearly states, low-cost CD-R technology will allow every desktop to become a CD-ROM publishing house. As such, this technology holds a great many benefits, such as giving users the ability to archive large amounts of data, and furthering software development. But CD-R technology also enables an end user to make copies of commercial CD-ROM software and multimedia titles, perhaps without authorization from the copyright holder. While the Software Publishers' Association (SPA) recognizes the beneficial applications of CD-R technology, we are also aware that CD-R drives are being used to make illegal copies of software. Before people use CD-R drives, they should be aware of the Copyright Act and the responsibility that goes hand in hand with the flexibility that a CD-R provides.

SANDRA SELLERS
Vice President of Intellectual Property, Education and Enforcement, Software Publishers' Association

Though it is encouraging to see that CD-R is now being considered by businesses as a viable solution for backup, storage, and distribution, you did your readers a disservice by stating that no software package currently provides drive letter access. In fact, Spira, from Moniker, has been on the market for more than a year and provides just that.

DAVID MULTER
President, Moniker Inc.
Scotts Valley, California

THE RIGHT TOOLS FOR THE JOB

I appreciated your roundup of leading authoring systems, "Create Your Own CD: Multimedia Authoring Tools" (April 9, 1996), though there was some information missing. It would be helpful to know the effort required to use these tools. The reviewers make it sound as if these high-end tools can just be picked up and mastered within a couple of hours, when in reality it takes several months to be able to use them efficiently.

M. DAVID MERRILL
Logan, Utah

As corporate users begin the migration to computer-based training, articles such as these help to clarify what is for most people a very complex decision. I hope your next review of multimedia authoring tools will also include programs for corporate developers who do not require the flexibility of the tools you reviewed, but who want to leverage their content expertise to produce multimedia.

MARTIN A. RENKIS
via the Internet

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MICHAEL J. MILLER

Why Buy a Perfect PC?

If you're like many of us here at *PC Magazine*, when you get an issue like this one you immediately begin to pore over the specifications for the latest computers and ponder which ones would be nice to own. You sift through the hardware and software reviewed in First Looks, looking for products that will help you be more productive, will be interesting to look at, or just look like fun.

Somewhere along the line, you talk about these things with friends. And inevitably, people are bound to overhear you discussing the pros and cons of the latest PCs, and they'll shake their heads as if to say, What's the point of all this? To the typical *PC Magazine* reader, this might seem like sacrilege, but to the world at large, it's a valid question. Why bother looking for the latest and greatest computer products? Why agonize over which computer to buy? Who really needs the Perfect PC?

After all, you can write documents, create budgets, play games, and connect to the Internet from just about any PC nowadays. And no matter what you buy, someone will have a faster, better model next year. Besides, we're talking about a computer, not world peace or a cure for cancer.

To be honest, these arguments have an element of truth. Most of today's machines are quite capable of performing the majority of the tasks users require. Nevertheless, there are a variety of reasons why you should care about which computer products you buy.

PHOTOGRAPH BY ANDY FREEBERG

THE PERFECT BUY

Let's face it: A PC is a big purchase, and choosing the right one makes a big difference.

The first reason is that you need to choose the right kind of machine for your specific needs. Although personal computers have a lot in common with one another, the term "PC" has been broadened to include anything from a battery-powered device you can fit in your shirt pocket to a multiple-processor server you lock in a climate-controlled room. Among the mainstream computers we looked at for this issue, for instance, we came up with 10 primary categories, ranging from desktops to notebooks to servers. Even within those categories, there is a lot of variation. Consider home computers: Some are designed for general use, while others are designed for specific tasks such as running a home business, providing the ultimate in gaming, or even serving as the family's entertainment center in the living room.

Once you've narrowed it down to the appropriate category, you must still grapple with differences in CPUs, graphics quality, and expandability. Finally, there are the less tangible characteristics of individual brands, such as the quality of construction, warranty, and level of technical support.

Let's face it: A PC is a big purchase, and choosing the right one can make a big difference. In fact, for many home users, a computer may well be a family's third-largest expense (after housing and transportation). Buying the right one now may mean it will last longer, cause fewer headaches, and cost less in the long run—especially for businesses that purchase many PCs at a time. Just as important for businesses are questions of compatibility, expandability, and management, because in many companies, hardware expenses are only a fraction of the total cost of managing and supporting computers.

And yes, part of the reason we care so much is that for many of us, it's just plain fun. We like computers. We think finding one that does more, works better for us, or breaks new technological ground is interesting. In a way, it's like transportation. True, anything from a Corvette to a Caravan will get you to the supermarket and back. But the Corvette won't hold too many grocery bags—let alone transport a family of five or haul lots of building materials. That's why you need to choose from the category that's right for your needs: sports car, sedan, station wagon or minivan, truck, or sport-utility vehicle. Even within these categories, there are substantial differences in such areas as performance, comfort, reliability, and image. The same concept is true of computers.

But in a way, computers are unique, because they can help us do so many different things. They may make us more productive at work, but they can also be a fun way to pass time playing games. Computers are ushering in a new era of education and learning, helping our children in ways we're only beginning to grasp. And though computers alone cannot cure cancer or prevent war, they play integral roles in medical research and in keeping the peace by fostering communication across political and geographic boundaries.

Nobody's perfect. Ultimately, there's no such thing as a Perfect PC either. But does that mean we should stop trying to find it? No way. □

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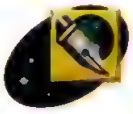

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The Font Forecast

Adobe and Bitstream recast type design for the Web.

World Wide Web pages have come a long way from their roots as minimally formatted text pages. Inline graphics, tables, frames, and Java applets now provide an increasingly rich browsing experience. Still, Web developers today cannot easily duplicate the highly formatted appearance of a magazine page. Adobe Systems and Bitstream have developed font technologies that promise to eliminate much of that gap.

ADOBE'S OPENTYPE SOLUTION

The OpenType initiative defines a new universal font format that combines Adobe's Type 1 (PostScript) font technology, predominant in the Mac world, and the Microsoft TrueType font technology predominant on PCs. In addition to supporting OpenType in their future application and operating-system releases, Adobe and Microsoft will jointly use OpenType as a basis for defining HTML type extensions that give Web authors greater flexibility in presentation of text.

Currently, Web authors cannot alter the appearance of a browser's default proportional and monospace fonts beyond controlling bold and italic attributes and making gross adjustments to type size. The new type extensions will permit designers to specify particular typefaces, font sizes, and attributes. OpenType fonts will support compression techniques to make their delivery over low-bandwidth connections practical.

Adobe's existing Portable Document Format (PDF) provides a platform content authors can use to retain the look and feel of their print documents, complete with typefaces, high-resolution images, and page layout, while also providing hypertext links, text searches, and other interactive capabilities. Currently, PDF files can be viewed with Adobe's Acrobat viewer and Acrobat Amber viewer, which are configured as helper applications within a Web browser.

Adobe's newly announced Embedded PDF (EPDF) capabilities will permit PDF files to be embedded directly within a Web page. The EPDF viewer will take advantage of Netscape's plug-in architecture and Microsoft's ActiveX technology. Adobe is also extending its PDF viewers to enable them to fill in forms electronically, thus providing the same interactivity currently available through HTML forms but with far more control over formatting and field validation.

BITSTREAM'S TRUEDOC SOLUTION

Some parts of Adobe's solution will have to slug it out in the marketplace with alternative approaches. In particular, Adobe's font-fidelity technology for the Web will go head-to-head with Bitstream's already-available TrueDoc system. Font fidelity means that online designers can include any desired font in a document with the assurance that the font and all of its attributes will display properly—even on systems that don't have the actual font installed.

TrueDoc's Character Shape Recorder (CSR) records a font's character shape information in compressed form, then transmits it along with the portable electronic document. TrueDoc's Character Shape Player (CSP) re-creates the original font shapes and attributes. Bitstream's Stefan Winnik points out that TrueDoc presents an already-available solution for including both TrueType and Type I fonts in portable electronic documents. "OpenType is a long way away," he says. "TrueDoc is available now."

In late April, Bitstream announced that Spyglass will include the TrueDoc CSP in the HTML component of Spyglass' Web Technology Kit. Since many versions of the Mosaic Web browser are based on Spyglass' kit, Mosaic implementers will easily be able to include TrueDoc in their browsers.

Bitstream has also developed a Java implementation of TrueDoc, which has already been used in the development of Texture, a portable document-authoring tool from FutureTrend.

Two competitors to Adobe's Acrobat portable document-distribution technology have also adopted TrueDoc. Common Ground Software's Common Ground 2.0 for Windows and Novell's Envoy both incorporate Bitstream's font-fidelity solution.

One of the more intriguing TrueDoc implementations can be found in the HexWeb online publishing applications from HexMac International of Germany. This Macintosh-based extension for QuarkXPress lets newspaper and magazine publishers quickly convert Quark files to HTML format for posting on Web servers.—*John Clyman and Jonathan Matzkin*

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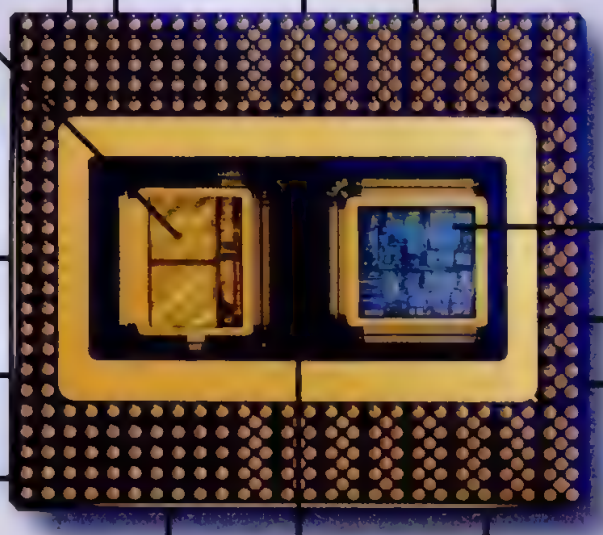

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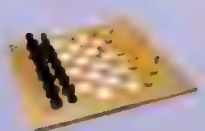

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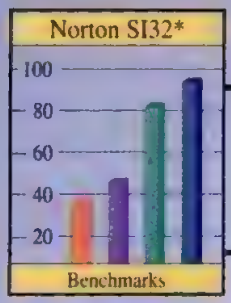

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Apple Chief Maps Future

Amelio calls for streamlined product lines.

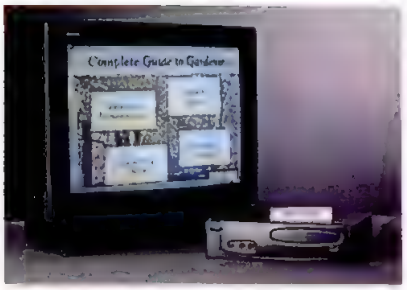
CEO Gil Amelio, following up on his promise to cap his first 100 days at the helm of Apple with a plan for the company's recovery, delivered a well-received keynote speech at Apple Computer's recent Worldwide Developers' Conference. "We must head off what many have said will be a long, slow decline into irrelevancy," Amelio said to a packed house of developers and press, many of whom had predicted that the decline might be short and fast.

Amelio spoke of plans to focus Apple's organization and motivation on two "megatrends," which he defined as Pervasive Connectivity and Pervasive Multimedia. He called for a reorganization to create four groups that would center on information appliances, the Macintosh, alternative platforms, and imaging.

Cost reduction is another imperative at Apple. Industry analysts had suggested two main ways to save Apple, both of which Amelio rejected because they put limits on the widespread appeal of the Macintosh platform. The first was to drop several of the markets around the world in which Apple competes. The second was to focus the company exclusively on high-end appliances.

Instead of these courses, Amelio will implement cost reduction through "product-line simplification." Specifically, he'll reduce the number of Apple motherboards from nine to five in six months and the number of distinct Apple system models by 50 percent in six months. Amelio will also do away with separate architectures, leaving only one Apple OS.

Specific details about Apple products included the announcement that all Macintosh models will ship with at least 12MB of DRAM, and that Apple and IBM will jointly develop a notebook based on the Macintosh OS. Apple will also make the Newton Internet Enabler, which facilitates hand-held Web browsing, available to developers.



PIPPIN PLATFORM: *Apple's reorganization calls for focus on information appliances.*

Amelio focused especially on the new Information Appliance division. He said that the under-$1,000 Pippin system had sold 16,000 units in Japan, and that he had high hopes for the mid-May U.S. launch of a browser-enabled version of Pippin.

As for the Macintosh profit-and-loss center, Amelio stressed the importance of building Internet functionality into the Macintosh operating system. Macintosh server shipments, he said, were up 40 percent in April.

The keynote address drew rousing applause, but exactly what the companywide reorganization will mean for employees remains unclear.—*Sebastian Rupley*

Computer Meets Appliance

Single-function, mass-market devices—for the kitchen?

Diba, a Belmont, California, startup headed by a cadre of former Oracle executives—some of whom worked directly with Oracle CEO Larry Ellison to develop the "network computer"—is gathering interest from consumer electronics manufacturers with its somewhat offbeat concept, Interactive Digital Electronic Appliances (IDEAs).

What's a Diba IDEA? About 42 of them are in development, all designed to marry brand-new hardware with Diba's software. IDEAs are designed to facilitate simple, focused tasks—such as retrieving e-mail or looking up a yellow-page listing—in an inexpensive, ultra-easy-to-use device.

Diba is working on an under-$300 yellow terminal designed for an office hallway. The terminal will feature yellow-page listings, much like the yellow-page listings proliferating at such Web sites as BigBook. Another Diba IDEA is an e-mail-only terminal, designed to fit into heavily trafficked areas of a house, such as the kitchen. The e-mail terminal will feature just a few simple keys with labels like "Create a Message."

JUST HANGIN' AROUND: *The Diba IDEAs are designed for extreme ease of use.*

Several IDEAs will appear this year. According to vice president of marketing Joe Gillach, Diba is "cherry-picking applications for our IDEAs that have very high demand and big existing infrastructures." He adds that Diba's founder, Farzad Dibachi, who ran Oracle's new media division, "was convinced that the network computer from Oracle was imperfect, because it was being designed by committee. It doesn't solve the fundamental ease-of-use problem. It's basically a 386 at a 386's price."

According to Gillach, Diba is working on new hardware designs with overseas manufacturers. Zenith has announced it will collaborate with Diba on interactive television technology that will incorporate Web browsing. Zenith's new NetVision sets—featuring infrared trackball remote controls and Ethernet connectors—will let you browse the Web, access e-mail, and run Java apps. Zenith plans to introduce large-screen NetVision sets later this year.—*Sebastian Rupley*

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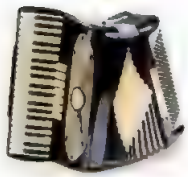

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Cyrix's Bold M2 Strategy

Upcoming chip simplifies the upgrade decision.

Rather than asking you to choose between the low road and the high road, Cyrix is offering a continuous path to 32-bit processing. By announcing plans for its M2 chip—a sixth-generation technology that will plug into a standard Pentium socket while offering both MMX compatibility and 32-bit optimization—the company is allowing users to purchase today's most adept mainstream hardware and gently upgrade to tomorrow's.

Although samples of the processor won't be ready until the fourth quarter and may not reach production quantities until the beginning of 1997, the recent success of the 6x86 chip has made Cyrix's plans a significant source of industry curiosity. New 6x86 P166+ systems—which have a clock speed of only 133 MHz—are outperforming most Pentium/166 machines and are even competing with imminent Pentium/200 PCs.

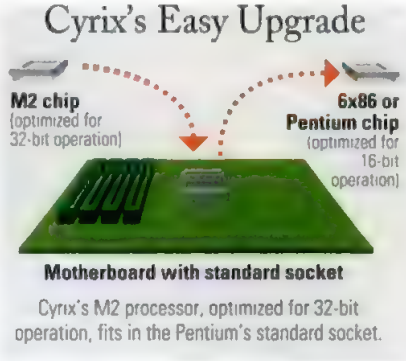
Like the 6x86, the M2 chip will offer most of the Pentium Pro's most attractive features—including register renaming, out-of-order completion, and speculative execution—but will also include a 64K primary cache. Currently, the Pentium Pro has a primary cache of only 16K, although it offers an on-board secondary cache as well. Unlike the 6x86, the M2 will boast optimization for 32-bit code and for MMX, an instruction set for boosting graphics and audio performance.

Of course, the Pentium Pro already offers 32-bit optimization and will offer MMX in its Klamath incarnation by the time the M2 is in production. What sets the two chips apart is the M2's compatibility with the 64-bit socket standard in the Pentium and the 6x86.

With Windows 95 here today and Windows NT 4.0 on the horizon, many corporations are struggling with hardware decisions. The Pentium and 6x86 are more suitable for Windows 95's 16-bit code, while the Pentium Pro is the processor of choice for Windows NT. Either you purchase today's most appropriate hardware and forsake it entirely when tomorrow's comes along, or you patiently endure archaic hardware for six months.

With MMX in the mix, the situation is even more difficult. You can vastly improve the performance of games and videoconferencing as soon as the Intel P55C ships with MMX this fall, but then you'll have to upgrade your entire system once you want 32-bit optimization.

Cyrix believes it has the answer. Users who require the highest performance under Windows 95 can purchase a 6x86 P166+ system today or a 6x86 P200+ machine (or a Pentium PC) this summer, then plug an M2 into the universal 64-bit socket after the first of the new year. Of course, if much of the corporate world decides to wait for the Klamath, then moves to it en masse, the 64-bit standard socket may not be very standard—or very available. Regardless, Cyrix is making its presence felt as no other Intel competitor ever has.—*Cade Metz*



Cyrix's M2 processor, optimized for 32-bit operation, fits in the Pentium's standard socket.

FireWire Plays Starring Role in Simple, Fast PCs

High-speed bus architecture moves into PCI territory.

If you thought you'd heard the last of the bus wars, think again. Microsoft's announcement of the Simply Interactive PC (SIPC) initiative has added momentum to the IEEE 1394 (FireWire) standard for high-speed serial data transfer. FireWire's increasing prominence will challenge SCSI, the reigning champion high-speed serial bus, and even PCI, which, though popular, doesn't easily adapt to the new world of plug and play.

FireWire will be a key technology for the SIPC initiative. Among FireWire's advantages over SCSI is its ease of connecting devices (up to 63), done in a manner similar to plugging into a phone jack. You don't even have to turn off the power when connecting a new device to the bus.

Intel is somewhat less wholehearted in its endorsement. Bob Gregory, director of strategic marketing for the PCI components division of Intel, believes that FireWire will emerge as "a standard interface for lots of peripherals." Gregory says that although Intel is enthusiastic about FireWire, PCI still has the primary role. Emphasizing that "lots of stuff needs to go inside the box, on the motherboard, before you seal it up," he adds that though the FireWire "platform vision is good," it will not replace PCI, which has a maximum transfer rate in excess of 1 gigabit per second (Gbps), anytime soon.

Just how fast is FireWire? Specifications allow for transfer rates of up to 400 megabits per second (Mbps). Intel's Universal Serial Bus (USB), also included in SIPC announcement, is much slower, at 12 Mbps. USB, viewed as complementary to FireWire, is to be used for peripherals that do not require high speed, such as keyboards and mice.

USB and FireWire may compete for mindshare, but little direct competition actually exists. On the other hand, with plans for 1-Gbps FireWire already in the works, PCI's current speed advantage may not be enough to keep it at the center of the PC architecture.

In May, Apple announced that it will bring FireWire to its entire product line beginning early next year. And by 1998, FireWire will be built right into the motherboard of all its desktops and notebooks. If this is a harbinger of developments on the PC side, it could mark the beginning of the decline of PCI.—*Marc M. Groz*

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2. **Netscape Navigator** Netscape Communications
3. **Microsoft Plus! for Windows 95** Microsoft
4. **First Aid** Cybermedia
5. **VirusScan** McAfee
6. **Norton Antivirus** Symantec
7. **Uninstaller** MicroHelp
8. **CleanSweep 95** Quarterdeck
9. **Netscape Navigator Personal Edition** Netscape Communications
10. **First Aid Deluxe** Cybermedia

Source: PC Data. Data for April 1996.

PIPELINE

By Jake Kirchner

I'm Just Glad *Somebody* Wants My Business

It wasn't exactly like donating all of my tie-dyed T-shirts to Goodwill Industries, but it sure felt like the end of an era when I canceled my MCI Mail account the other day. After ten years through thick and thin, it was time for us to go our separate ways.

The final straw came in February, when MCI announced it would start charging a minimum $10 monthly fee for any MCI Mail box. The move was made to curb what the company called "service abuse." Ouch, I thought. I didn't like the idea that my decade-long relationship with the company had devolved into an abusive one. But I just couldn't see paying $120 a year to receive the one or two messages a month that trickled into my personal MCI Mail box.

Free e-mail companies have figured out how to take abusive, vain people like me and still make money.

An MCI spokesman further explained that people like me, who hold MCI Mail accounts almost entirely to receive mail (which used to cost me nothing) rather than to send mail (which generates income for the company), are thought of by MCI as having "vanity mailboxes." Ouch again. I would have thought there were lots of folks like me on the MCI rolls, but the company assured me otherwise. The spokesman said that a very small percentage of the 2 million or so MCI Mail users are affected by the new pricing structure and that less than 10 percent of those customers have dropped their accounts in response to it.

Well, I thought, I can't blame a company for forcing me out the door if it's losing money by servicing my account. And it's not as though I need the MCI Mail box along with my three other e-mail addresses. (One of them, I should note, is a corporate MCI address.) Hey, no hard feelings on my part—certainly not to the extent that I'd consider ending my 15-plus years as a customer of MCI's long-distance services. (Note to AT&T: *Please* stop hounding me to switch!)

But I have to say I didn't like the fact that despite my customer loyalty, I had come to be considered a drag on MCI's business. And I'm a little disappointed that a longtime industry leader like MCI couldn't have come up with a more innovative approach to this problem than hitting me up for more money in an effort to make me mail or bail.

This is particularly annoying when there are companies fighting to offer me free e-mail accounts. Truly innovative companies, like D.E. Shaw & Co. in New York, which is advertising its new Juno service (*www.juno.com*), and Freemark Communications in Cambridge, which is preparing a similar service (*www.freemark.com*), have figured out a way to take abusive and vain people like me and actually make money by providing us with free e-mail services.

Both these companies are fielding full-blown e-mail systems supported by advertising rather than customer fees. Of course, I'm not thrilled with the idea of having ads pumped into my e-mail—but then, I said the companies were innovative, not saintly. MCI, evidently, is neither when it comes to e-mail.

Get Ready for Massive Hard Disks...

... and for plenty of software incompatibilities.

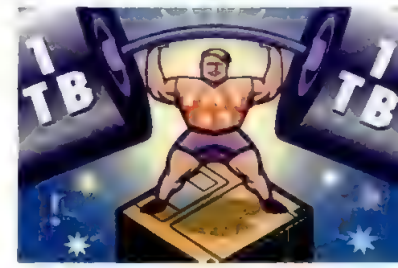
One of the cardinal sins of the operating system business is to commit incompatibility: Thou shalt not break existing software. Yet developers sometimes get away with it.

Microsoft is just about ready to deliver a service release—known as an OEM release—of Windows 95 to PC manufacturers that includes a new file system called FAT32 (file allocation table). (Microsoft is not adding it to the retail version.) FAT32 supports hard disks of up to 2 terabytes (TB)—a thousand times greater than Windows 95's current 2GB limit. FAT32 also greatly expands the number of clusters on a logical drive, so Windows 95 will no longer need to allocate a large amount of disk space to even the smallest files.

Unfortunately, FAT32 causes enough havoc with existing disk utilities that its advantages may not, for some users, outweigh the price of incompatibility. Changing the layout of the file structures on the hard disk will cause utilities such as Symantec's Norton Utilities Disk Doctor to fail. This is frustrating not only for end users, but also for developers, who must revise their products to accommodate the new layout.

And the problems don't end there. It's not only disk utilities that will need updating: Some antivirus utilities, compression tools such as Stacker, tape backup utilities, security products such as Norton DiskLock, and uninstallers will choke under FAT32.

FAT32 may also adversely affect games, since many of them use copy protection schemes—especially those involving hidden files or files in fixed positions—and direct disk access to increase speed. Still, the majority of software will not have a problem. After all, most software already works with NTFS under Windows NT.



While Microsoft is readying the upgrade, PC vendors are on the verge of shipping PCs with hard disks larger than 2GB. Some of these systems will ship before the service pack is ready.

As a workaround, some PC vendors will partition large disks into two or more logical drives. Some of them follow standard schemes: typically, 2GB to the C: drive and the rest to the D: drive. Other vendors will ask buyers how they want their hard disks partitioned. Buyers concerned about their hard disk layout should ask before putting in an order.

Because of the significant incompatibilities involved, some PC vendors may opt to install FAT32 only when necessary.—*Larry Seltzer*

ILLUSTRATION BY BRAD HAMANN

(Of course, you'll have to pay a little less for it.)

O.K. You know where you want to go. Now, how fast do you want to get there?

With the new Winmodem from U.S. Robotics, you actually harness the power of your Windows operating system to fax, check E-mail, and search the net faster and more efficiently than with any other modem.

Not to mention, of course, more affordably.

Plus, unlike other modems, Winmodem gives you the proven compatibility and reliability of Sportster,® the number one selling modem in the world. It's easy to install, it's Microsoft Plug and Play certified, and it can be upgraded instantly to 33.6 Kbps with one call to the U.S. Robotics BBS.

What's more, the exclusive U.S. Robotics *Connections* CD-ROM offers you a wide selection of online products for both home and office.

To learn more about the Sportster Winmodem, or any of the other ways U.S. Robotics takes the limits off how fast you can get what you want, call us at 1-800-DIAL USR, or visit us at www.usr.com.

U.S. Robotics

NO LIMITS

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First Looks

HANDS-ON REVIEWS OF NEW SHIPPING PRODUCTS

PENTIUM PCs

Pentium/200: Fast PC or Low-Cost Workstation—Your Choice

By Cade Metz and John Morris

Intel's 200-MHz flagship Pentium processor is trying to be all things to all computer users. The Pentium/200 chip delivers both the best all-around performance under Windows 95 and enough horsepower to serve as an entry-level Windows NT workstation—at desktop PC prices—for heavy-duty engineering and graphics applications.

Like its 166-MHz predecessor, the Pentium/200 processor is manufactured using Intel's 0.35-micron semiconductor process. It comes in new packaging, called Plastic Pin Grid Array (PPGA), which improves the processor's ability to disperse heat in comparison with the old ceramic packaging—not an inconsequential consideration for a CPU that uses 17 watts of power. Despite the new trappings, the Pentium/200 processor has the same electrical characteristics as earlier chips and plugs into existing motherboards.

We tested the first five Pentium/200 systems we've seen: Dell's Dimension XPS P200s, the Gateway 2000 P5-200XL, the IBM PC350, the Micron Millennia P200, and the Sys Performance P200T2. Ranging in price from $3,100 to $4,500, each of these PCs came equipped with an Intel-made high-speed PCIset chip set, 512K of external cache, and a 17-inch monitor.

In addition, two systems stood out from the field: The Gateway P5-200XL came with a recordable CD-R drive, and the IBM PC350 had the first Universal Serial Bus (USB) plugs we've seen, although no USB devices exist.

We tested this group running Windows 95 (with 16MB of RAM) and Windows NT 3.51 (with 32MB of RAM). Aside from system memory, the system configurations were the same on both test suites.

Using Windows 95, these Pentium/200 PCs performed about 10 percent better than their 166-MHz counterparts on our Winstone 32 and Winstone 96 benchmark tests—less than you'd expect from a 17 percent increase in clock speed, which points to the

Continues on page 40

MEMORIES: *Dell's Dimension XPS P200s uses high-performance synchronous DRAM.*

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WORLD WIDE WEB

Finding Your Needle in the Web's Haystack

By John Clyman

As the World Wide Web grows exponentially in size and scope, finding what you're looking for can seem a daunting task. The decentralized nature of the Web is part of the Web's allure, but it also leads to a sense of chaos.

Nimble entrepreneurs have stepped into this void, deploying a variety of tools called *search engines* that claim to tame the Web's tangled tentacles. Many of these search engines are among the most popular sites on the Web and have evolved into full-blown information clearinghouses that offer news wires, regular features such as rundowns of "cool" sites, and independent editorial content.

We looked at the most popular search engines and a handful of the lesser-known but worthwhile sites to see which deserve a bookmark in your browser. All of the sites we reviewed are free services. You can also find additional reviews on *PC Magazine*'s InternetUser site at *http://www.pcmag.com/IU*.

ALTAVISTA

Digital Equipment Corp.'s AltaVista (*http://www.altavista.digital.com*) is the most comprehensive and powerful full-text search engine on the Web today. In our test searches, it often unearthed five to ten times as many matching documents as its nearest competitor. And while it occasionally seemed overzealous, returning much chaff with the wheat, on the whole it was remarkably accurate.

To use AltaVista's default Simple Search, just type in the words you're looking for and press the Submit button. Because AltaVista will often find hundreds or thousands of matching documents, you'll also want to familiarize

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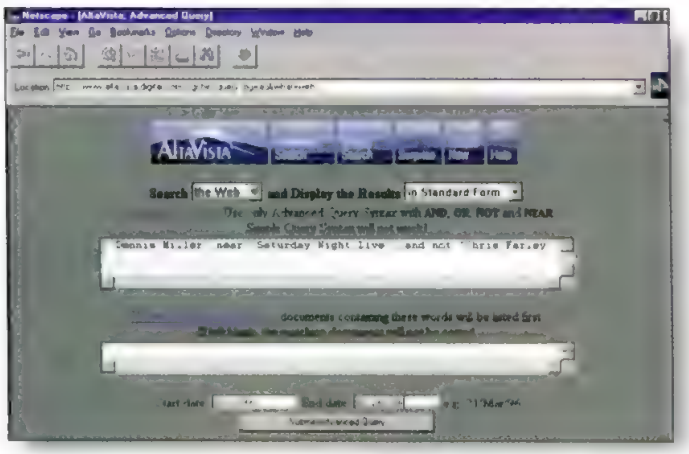


ZEROING IN: *Digital's search engine, AltaVista, offers powerful search capabilities, including Boolean searches, proximity operators, and date ranges.*

Pentium/200 PCs

Continued from page 39

possibility that these systems may be constrained by the 66-MHz system bus or I/O bottlenecks.

Expect to see some PCs sporting 75-MHz buses later this year as well as 200-MHz MMX Pentium processors that will push graphics and multimedia performance to new heights. In addition, Cyrix will have a 200-MHz-class chip by the end of the summer.

In terms of workstations, these Pentium/200s were only a tick slower than the 150-MHz Pentium Pro systems we looked at earlier this year (First Looks, February 6, 1996). The one constant factor on both the Windows 95 and Windows NT tests was the dominance of the Sys P200T2: It not only consistently outperformed the rest but was one of the least expensive systems tested.

Whether you spend your day working in AutoCAD or Adobe Photoshop in Windows NT or using mainstream Windows 95 applications, these versatile Pentium/200 PCs offer a compelling combination of performance and value.

DIMENSION XPS P200s

The $3,099 Dimension XPS P200s extends Dell's tradition of delivering high-end PCs at aggressive prices with a mix of high-end peripherals and innovative memory architecture.

The Dimension XPS P200s is based on Intel's 430VX chip set and is equipped with 16MB of synchronous DRAM (SDRAM) and 512K of pipelined-burst cache. SDRAM can improve performance by streaming data to the processor at a continuous rate that's in tune with the system's clock.

Both the Dimension XPS P200s and the Sys P200T2 were equipped with the formidable 1GB Quantum Fireball Enhanced IDE hard disk. The problem is that Quantum is not producing them anymore, so expect Dell and Sys Technology to substitute another drive after Fireball supplies have run out.

The Dimension XPS P200s is rounded out with a Number Nine Technologies Imagine128 Series II PCI graphics card with 4MB of VRAM, an 8X CD-ROM drive, a U.S. Robotics Sportster V.34 modem, and a 17-inch UltraScan monitor. For audio, there are Altec Lansing speakers and a 16-bit Creative Labs Sound Blaster card.

The mini-tower case, which is identical to that of the Millennia P200, allows easy access to all components by removing a single side panel. Inside, the system has three PCI and two ISA expansion slots, as well as one shared connector.

The Dimension XPS P200s produced consistent though not dazzling scores on both Windows 95 and Windows NT tests. On Windows 95 tests, it notched the second-highest Disk WinMark 96 score of 1,180 and yielded strong scores of 371 and 372 on the $CPUmark_{16}$ and $CPUmark_{32}$ processor tests, respectively. The Dimension XPS P200s did not fare as well on our Winstone 96 and Winstone 32 benchmark tests, however.

DEEP STORAGE: *The Gateway 2000 P5-200XL is equipped with a recordable CD-R drive.*

Under Windows NT, the Dimension XPS P200s had the second-best score on our Winstone 32 tests, the C Compiler test, and the AutoCAD test. On the Photoshop tests, however, the Dimension XPS P200s lagged behind the group.

It should be noted that Dell doesn't fully support Windows NT—though we didn't experience any problems installing or running the operating system during testing.

The Dimension XPS P200s, which includes Microsoft Office Professional, is one of the best all-around PCs you can buy today.—*JM*

Dimension XPS P200s. List price: With Pentium/200 CPU, 16MB RAM, 512K external cache, 1GB hard disk, 8X CD-ROM, 17-inch monitor, $3,099. Dell Computer Corp., Austin, TX; 800-289-3355, 512-338-4400; fax, 800-727-8320. *Circle 430 on reader service card.*

GATEWAY 2000 P5-200XL

The $3,899 Gateway 2000 P5-200XL stands out in this group by packing a Panasonic recordable CD-R drive into the system's full-size tower case.

Based on the Intel Tiger motherboard and 430VX PCIset chip set with 16MB of SDRAM, the P5-200XL is equipped with 512K of pipelined-burst external cache and a 2.5GB Western Digital Caviar Enhanced IDE hard disk. Although most of the systems we tested included 4MB of video memory, the P5-200XL relies on 2MB of WRAM and a Matrox MGA Millennium graphics card; it's still able to produce 1,024- by 768-resolution graphics at 256 colors on its 17-inch Vivitron monitor.

In addition to the CD-R drive and an 8X CD-ROM drive, the P5-200XL has a 16-bit Ensoniq sound card with wavetable synthesis and Altec Lansing ACS-400 speakers; the package also includes an ACS-250 subwoofer and a Telepath V.34 modem. Inside the tower case, there are three PCI and two ISA slots, as well as a shared connector. One PCI slot is occupied by the interface card for the CD-R drive.

On Windows 95 tests, the P5-200XL's scores were in the middle of the pack. In general, it outperformed the Dimension XPS P200s and IBM PC350 but lagged behind the Millennia P200 and the Sys P200T2. The exceptions

PC WITH A VIEW: *The IBM PC350's monitor led the pack.*

were the P5-200XL's results on the processor tests, which were among the lowest in the group.

The P5-200XL remained solidly in the middle of the group on Windows NT tests with scores of 121 on the Winstone 32 tests and 4 minutes 43 seconds on the AutoCAD test, as well as average results on Photoshop applications. Its time of 2 minutes 53 seconds on the C Compiler test was one of the worst, however.

The P5-200XL includes Microsoft Office 95 and a slew of CD-ROM–based software. Despite its less-than-stellar performance on our benchmark tests, the P5-200XL, with its built-in recordable CD-R drive, could be the first of a new breed of inexpensive multimedia workstations.—*JM*

Gateway 2000 P5-200XL. List price: With Pentium/200 CPU, 16MB RAM, 512K external cache, 2.5GB hard disk, 8X CD-ROM, recordable CD-R drive, 17-inch monitor, $3,899. Gateway 2000 Inc., No. Sioux City, SD; 800-846-2000, 605-232-2000; fax, 605-232-2023. *Circle 431 on reader service card.*

IBM PC350

At $4,462, the IBM PC350 is by far the most expensive PC of this high-flying group. It is also a graphics paragon that is built around one of the best desktop monitors available.

Although each of the other sys-

tems in this roundup is limited to an upright tower configuration, the IBM chassis can also lay flat, like a desktop case—either on its own or beneath the monitor. The unit's plastic cover is easily removed to reveal its carefully arranged components: a 430HX chip set, 16MB of RAM, and 512K of external cache. A 1.6GB Western Digital Caviar Enhanced IDE hard disk and a Matrox Millennium card with 4MB of WRAM complete the package.

On the front of the machine, there's a retractable plastic panel that can be locked to protect the 6X CD-ROM drive and the floppy disk drive. This leaves one available 5.25-inch bay and one 3.5-inch bay; there are four shared PCI/ISA slots and one ISA slot.

The rear of the machine offers a glimpse at the future of PCs: The system's pair of USB interfaces is the first set of USB plugs we've seen on a PC. Too bad that there are neither peripherals nor drivers available for them at this time.

The PC350 was an average to below-average performer. On Windows 95, its midrange scores on the Winstone 96, Graphics WinMark 96, CPUmark$_{16}$, and CPUmark$_{32}$ tests were offset by poor showings on the Disk WinMark 96 and Winstone 32 tests. With the only 6X CD-ROM drive in a sea of 8X units, the PC350 posted a CD-ROM WinMark 96 score that lagged behind the group.

The Windows NT tests told a similar story: The PC350's AutoCAD and C Compiler results were each the slowest recorded, and its Winstone 32 score was the second-lowest. The system's Photoshop results were bested only by the scores of the Gateway P5-200XL and the Sys P200T2.

The bright spot was the IBM P70 17-inch monitor, which consistently rendered images with immaculate clarity. There was never obvious granularity or imperfection. This graphical adeptness, however, was marred by the system's muteness, because neither sound card nor speakers were included.

In terms of raw performance, the PC350 had difficulty keeping up with the Joneses, but the integration of USB plugs and stunning graphics performance make it a system ahead of its time.—*CM*

IBM PC350. List price: With Pentium/200 CPU, 16MB RAM, 512K external cache, 1.6GB hard disk, 6X CD-ROM, 17-inch monitor, $4,462. IBM PC Co., Armonk, NY; 800-426-2968; fax, 800-426-4329. *Circle 432 on reader service card.*

PERFORMANCE TESTS

Pentium/200 PCs

The Sys Performance P200T2 dominated this high-flying group of 200-MHz Pentium PCs on both Windows 95 and Windows NT tests. The Dell Dimension XPS P200s and Micron Millennia P200 were close behind on most Windows NT tests. All five of the systems we tested outperformed the average comparably equipped Pentium/166 PC.

To measure performance under Windows 95, we used ZD Winstone 96, Version 1.0; ZD Winstone 32, Version 1.0; and ZD WinBench 96, Version 1.0. Each system came with 16MB of RAM and a 6X or faster CD-ROM drive.

To evaluate performance under Windows NT, we used ZD Winstone 32 and test scripts for three high-end applications. Each system was equipped with 32MB of RAM and ran the workstation version of Windows NT 3.51.

Windows 95

Higher scores represent better performance Bold type denotes first place	ZD Winstone 96 Score	ZD Winstone 32 Score	ZD Graphics WinMark 96 Mpixels/sec	ZD Disk WinMark 96 Score	ZD CPUmark$_{16}$ Score	ZD CPUmark$_{32}$ Score	ZD CD-ROM WinMark 96 Score
Dell Dimension XPS P200s	78	99	34.2	1,180	371	372	712
Gateway 2000 P5-200XL	80	102	32.9	1,140	366	364	805
IBM PC350	80	99	35.9	1,040	375	366	603
Micron Millennia P200	82	103	38.4	1,110	310	371	749
Sys Performance P200T2	**86**	**104**	**38.6**	**1,240**	**382**	**381**	**813**
Average Pentium/166 PC (June 25, 1996)	73	91	28.9	1,131	316	317	N/A

N/A—Not applicable. We are not reporting this score because the Pentium/166 PCs we reviewed included 4X as well as 6X and 8X drives.

Windows NT

▲ Higher scores represent better performance ▼ Lower scores represent better performance Bold type denotes first place among Pentium/200 PCs	ZD Winstone 32 Score ▲	AutoCAD Min:sec ▼	C Compiler Min:sec ▼	Photoshop Gaussian Blur Seconds ▼	Photoshop Lighting Effects Seconds ▼
Dell Dimension XPS P200s	124	4:36	2:46	60	84
Gateway 2000 G6-200 (Pentium Pro/200; May 28, 1996)*	N/A	3:26	2:06	48	67
Gateway 2000 P5-200XL	121	4:43	2:53	58	66
HP Vectra XU (Pentium Pro/150; May 28,1996)*	N/A	3:56	2:22	31	60
IBM PC350	122	4:53	2:56	57	68
Micron Millennia P200	101	4:44	**2:45**	59	71
Sys Performance P200T2	**129**	**4:35**	2:49	**55**	**64**

* Reported for comparison. N/A—Not applicable. This system was tested before ZD Winstone 32 was available.

The **AutoCAD** test exercises a broad range of system functions, including the CPU (both integer and floating-point math), disk, and video. The AutoCAD script opens files, performs 2-D and 3-D manipulations, and renders in 3-D. The **C Compiler** test uses the World Wide Web Consortium (W3C) Reference Library benchmark test, which consists of 119 files that contain 1.1MB of code. Programs were compiled using Version 7.20 of Symantec's C++.

We use two plug-in filters for Adobe Photoshop to test the integer and floating-point math abilities of these five systems as well as their suitability as high-end graphics workstations. The **Gaussian Blur** test is composed of integer operations and applies a blur to a high-resolution digital photograph, while the **Lighting Effects** test is composed of floating-point operations and changes the placement and intensity of lighting in an illustration.

MICRON MILLENNIA P200

A thoroughly cutting-edge PC, the $3,257 Micron Millennia P200 offers an excellent mix of value and performance.

Although the Millennia P200 uses the same chassis as the Dimension XPS P200s, its components are decidedly different. A Micronics motherboard houses a 430HX chip set, 512K of external cache, 16MB of EDO RAM, and an expansive 2.5GB Western Digital Caviar Enhanced IDE hard disk. The Millennia P200 debuts the Diamond Stealth 3D 2000 graphics card, which makes use of EDO RAM as well as an S3 ViRGE 3D accelerator chip.

The system also offers a 17-inch Micron monitor, an 8X CD-ROM drive, and a Creative Labs Sound Blaster card with wavetable synthesis. Expansion slots include three ISA slots, three PCI slots, and one ISA/PCI shared slot.

On Windows 95 tests, its Winstone 96, Winstone 32, and Graphics WinMark 96 scores were second to those of the Sys P200T2. The Millennia P200's solid benchmark test performance was marred by a few missteps.

When running Windows NT, the Millennia P200 turned in an anemic Winstone 32 score of 101, but it rebounded to deliver average AutoCAD, Gaussian Blur, and Photoshop Lighting

Effects test scores. The bright spot was its C Compiler test result, which was the fastest of the five machines.

A good performer packed with solid components, the Millennia P200 provides a lot of PC for the money.—*CM*

Micron Millennia P200. List price: With Pentium/200 CPU, 16MB RAM, 512K external cache, 2.5GB hard disk, 8X CD-ROM, 17-inch monitor, $3,257. Micron Electronics Inc., Nampa, ID; 800-388-6334, 208-893-3434; fax, 208-893-3424. *Circle 433 on reader service card.*

VALUE: *The $3,257 Micron Millennia P200 provides a lot of PC for the dollar.*

SYS PERFORMANCE P200T2

In keeping with the company's history of producing first-rate made-to-order corporate machines, Sys Technology surrounds the $3,099 Sys Performance P200T2's cutting-edge processor with the market's most adept and expensive components.

Like the IBM PC350 and the Millennia P200, the Sys P200T2 is built around the 430HX chip set, 512K of external cache, and 16MB of EDO RAM. The system's performance edge lies in its pairing of a Quantum Fireball 1.3GB hard disk and a Matrox Millennium graphics card with 4MB of WRAM—an all-but-unbeatable combo.

The Sys P200T2 is housed in a cramped mini-tower case, which provides two available 5.25-inch bays and one unused 3.5-inch bay. The system uses a Giga-Byte motherboard, along with an 8X CD-ROM drive and a Creative Labs Sound Blaster 32PnP Wavetable sound card. Accouterments include a 17-inch MAG Technitron monitor, two MLi 65 stereo speakers, and a Cardinal V.34 modem.

The Sys P200T2 produced a string of Windows 95 performance records on our Winstone 96 (86), Winstone 32 (104), Graphics WinMark 96 (38.6 million pixels per second), and Disk WinMark 96 (1,240) tests. The system's 382 and 381 scores on our $CPUmark_{16}$ and $CPUmark_{32}$ processor tests, respectively, were also unmatched.

Performance under Windows NT was equally stunning. Most impressive was the Sys P200T2's Photoshop Lighting Effects test result, which was even faster than that of a Pentium Pro/200 system.

OVERACHIEVER: *The Sys Performance P200T2 outperformed the rest of the Pentium/200 pack.*

Who says the best has to cost more? The Sys P200T2 shows that economy and speed are not mutually exclusive terms.—*CM*

Sys Performance P200T2. List price: With Pentium/200 CPU, 16MB RAM, 512K external cache, 1.3GB hard disk, 8X CD-ROM, 17-inch monitor, $3,099. Sys Technology, Cypress, CA; 800-613-9963, 714-821-3900; fax, 714-821-9592. *Circle 434 on reader service card.*

Web Search Engines

Continued from page 39

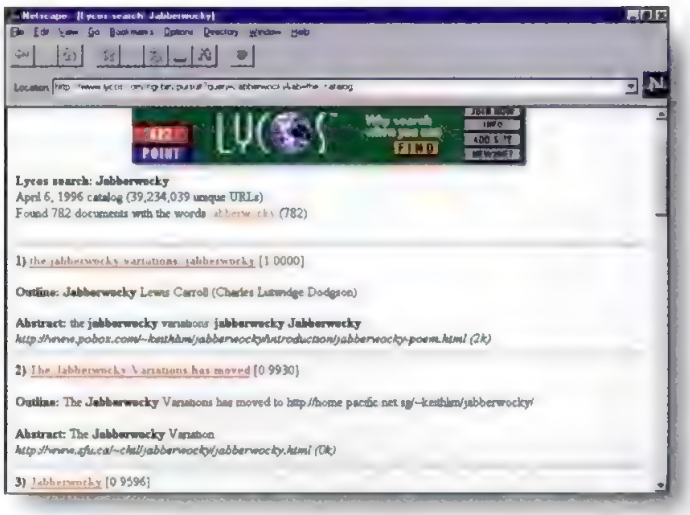
yourself with its Advanced Search feature. There you can specify Boolean operators (*and*, *or*, and *not*); specify the distance between keywords; perform case-sensitive searches; limit your searches to Web pages with a specific date range; use wildcards, either at the end of a search string or within a word; and restrict your search to specific elements, such as links. Furthermore, you can ask AltaVista to give priority to documents that contain certain words.

Unlike many search engines, AltaVista makes no attempt to rate sites or organize them into a hierarchy. But if you're looking for a Web page (or Usenet discussion group) that contains specific text, there's no better place to begin your search.

EXCITE

One of the first search engines, Excite (*http://www.excite.com*) is a full-text search tool that seems to be slipping behind the competition. In our test searches, Excite generally found fewer sites than the other search engines. And Excite has a number of quirks that detract from its appeal.

WORD FINDER: *Lycos highlights your search terms in its listing of the search results.*



For example, on the opening search screen, you must decide whether to search "by keyword" or "by concept." But the two types of searches usually produce identical results. In addition, Excite doesn't let you modify your original query from the results page and resubmit it; instead, you must first click on the Refine Search button. By default, Excite ranks search results by degree of confidence, and it provides a rating from 0 to 100 percent. But we found this rating a poor indicator of the actual relevance and quality of information.

We did like Excite's "query-by-example" feature, which is the same as InfoSeek's "similar pages" link. Like its competitors, Excite contains Web-site reviews and a Reuters news feed, plus comics and columns.

Although some of the excitement has worn off, Excite continues to offer a variety of news and features with its basic search engine, and its "query-by-example" feature can be useful.

INFOSEEK

InfoSeek Guide (*http://guide.infoseek.com*) is a free search service from InfoSeek Corp., which also offers a paid service called InfoSeek Professional. The Professional service includes business periodicals and news wire services, as well as the Web pages, Usenet discussions, and other resources searched by InfoSeek. Like Excite and Lycos, InfoSeek offers categorized site reviews in addition to full-text searches of Web pages.

On our tests, InfoSeek generally found sites that had the information we were looking for, although its listings offered nowhere near the breadth of

STREET PRICE...

$3895

Think of it as a supercomputer with a touchpad.

Move over Hal. Because AMS has given birth to a new, portable giant. We named it the PowerCD 8700. With a Pentium® Processor waiting to be unleashed, up to 40MB of RAM ready to perform, and storage space up to 2.1 Gigs, the PowerCD 8700 is truly one supercomputer.

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AltaVista's. If you click on the "similar pages" link, InfoSeek tries to find any pages whose contents correlate closely to those of the page you selected—without requiring any additional refinement of the search on your part. This feature is particularly helpful if you're searching for a word that can have different meanings in different contexts.

Furthermore, when you perform a search, InfoSeek often provides links to topics it suspects are related; if you click on one of those links, you'll jump to that area in InfoSeek's site reviews, which are similar to those of Yahoo! but less extensive. The related-topics list occasionally proved unreliable, though; when we searched on a popular brand of beer, InfoSeek suggested "Macintosh Webhelper applications."

InfoSeek supports Boolean operators, case-sensitive searches, and matches against complete phrases, and it lets you specify whether a pair of words should be *adjacent* or *nearby* (the latter meaning within 100 words).

Altogether, InfoSeek is a competent, useful, and feature-rich Web search engine, although its related-topics function can sometimes lead you astray.

LYCOS

Like InfoSeek, Lycos (*http://www.lycos.com*) combines a full-text search capability, called the Lycos Catalog, and a pair of Yahoo!-style searchable Web-site indexes. Unfortunately, neither index—Lycos's A2Z Directory nor Point's list of the so-called Top 5 Percent of All Web Sites—is particularly comprehensive, and our test searches quickly convinced us that Yahoo! is a better place to start.

On the other hand, the Lycos Catalog is relatively powerful. Lycos was consistently able to find more relevant Web pages than either Excite or InfoSeek, though it still paled in comparison with AltaVista. Lycos highlights occurrences of keywords in the results it returns, which helps you see at a glance whether the words are used in the context you intended. Lycos "stems" words that you enter, so that a search on *food* also uncovers pages that contain the word *foods*.

When you dig deeper, though, you'll quickly discover Lycos's limitations. You can tell it to exclude pages that contain a certain keyword, but you can't require that a keyword be present. Nor can you match complete phrases. As a result, some searches can produce completely inappropriate results. And though Lycos lets you use wildcards, you must use the "$" symbol rather than the near-universal asterisk. There is no Boolean search capability.

On the whole, Lycos is a powerful search engine, but its search tools are less than intuitive.

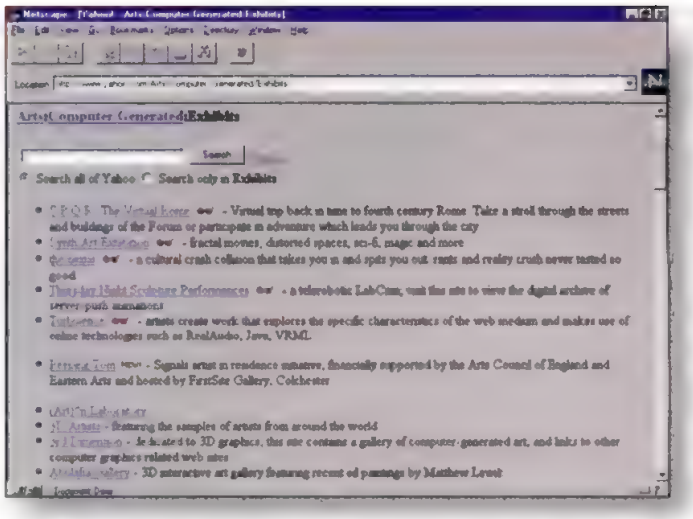
WEBCRAWLER

Owned by America Online's Global Network Navigator, WebCrawler (*http://webcrawler.com*) is an adequate but hardly extraordinary Web search engine. In our test searches, it typically returned relatively few matches compared with the other engines. Although WebCrawler includes GNNselect Web-site reviews, the reviews are not searchable, as they are in Lycos.

To its credit, WebCrawler maintains a spartan and unimposing user interface that belies its sophisticated search tools. The site handles Boolean operators, quotation marks (to denote a sequence of words that must be matched exactly), and *adjacent* and *near* operators. But without a substantive list of sites underlying its search functions, WebCrawler is less effective than some of the alternatives.

FIRST LOOKS PLUS

From July 1 to 5, go online to discuss Web search engines with John Clyman, a senior technical editor of PC Magazine Online, and executives responsible for each of the products reviewed here. Type GO EDITOR on CompuServe.



FRIENDLY FACE: *Yahoo!'s human touches are evident in many places, such as the sunglasses icons, which indicate cool sites, and the useful site summaries.*

YAHOO!

The first and probably most well known of the search engines, Yahoo! (*http://www.yahoo.com*) is technically not a search engine at all—it's a searchable index. Although most search engines use automated agents, called *spiders*, to follow every hyperlink on a page and tools that automatically index the individual word on that page, Yahoo! relies on real people to examine sites, summarize their contents, and place them into the appropriate sections of Yahoo!'s hierarchical category structure.

A good example of this human approach is the ZD Net site maintained by *PC Magazine*'s parent company, Ziff-Davis Publishing. The site is listed under the categories Business and Economy, Companies, Publishing, ZD Net, and Ziff-Davis Publishing. The Yahoo! site includes links to site reviews published by *Yahoo! Internet Life*, a joint venture of Yahoo! and Ziff-Davis.

When you visit Yahoo!, you can either drill down through the categories or search for terms that appear either as part of a category title or in a site's summary. Yahoo! affords little control over the specifics of the search, but that's generally not a problem because the site's careful organization yields highly accurate results.

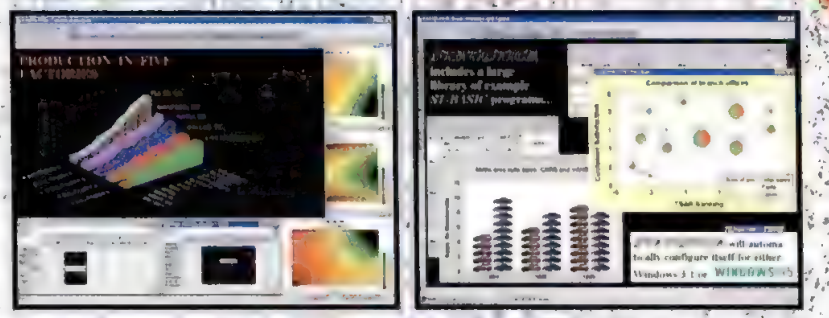
Because the search results are listed by category, it's easy to locate similar sites by simply clicking on the matching category headings. Yahoo! highlights the best sites in each category with a sunglasses icon and preferential positioning in the search-results list.

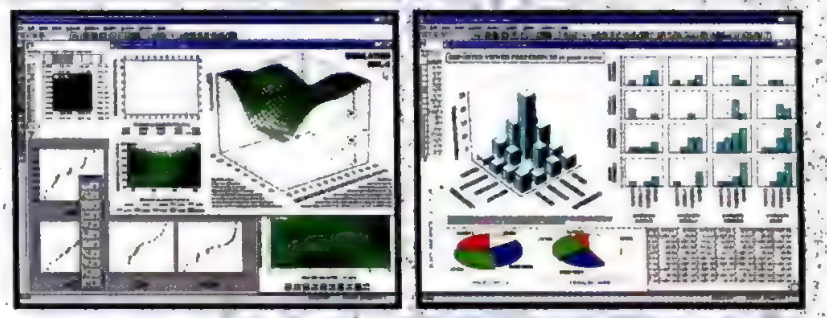
The downside of Yahoo!'s approach to cataloging the Web by hand is that the selection is nowhere near as deep or as broad as that offered by AltaVista. Furthermore, Yahoo! doesn't allow you to perform a full-text search for specific words on a page—the words must appear in the category name or site summary. As a result, Yahoo! is particularly weak when it comes to looking for proper names, such as product brand names. Yahoo! does incorporate results of full-text searches performed by a separate search engine, Open Text, but we found that a poor substitute for a dedicated full-text search tool.

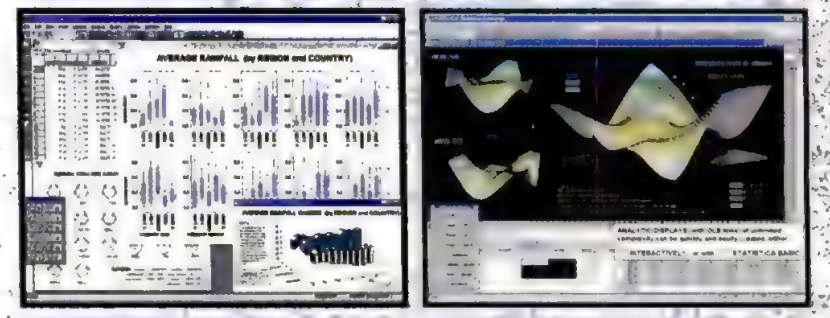
Beyond its Web-site index, Yahoo! offers searches of e-mail addresses and Usenet newsgroups, a news feed from Reuters, daily and weekly listings of cool Web sites, and an index to major new launches. For younger cybersurfers, Yahoo! maintains a separate Web site, Yahooligans (*http://www.yahooligans.com*), that focuses on sites of interest to kids and is screened for inappropriate content.

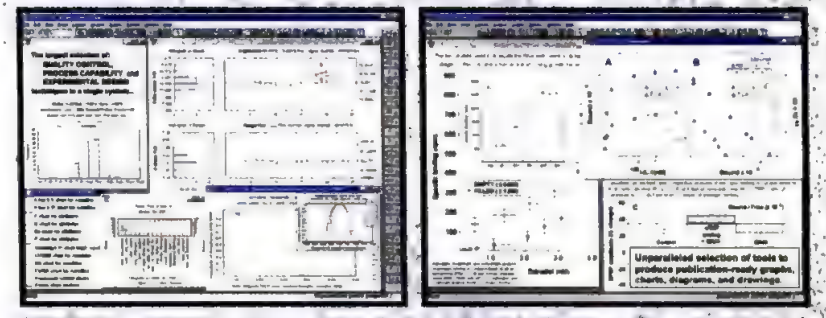
Yahoo! trades advanced search controls for an index of handpicked sites that consistently produces relevant and useful search results.

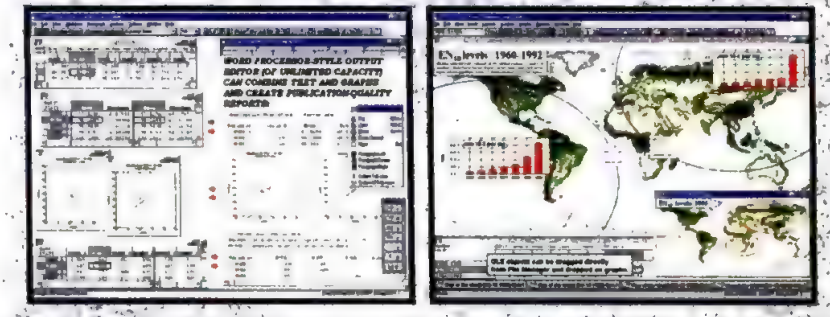
STATISTICA











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WIRELESS

JetEye *Net Plus* Beams Your Notebook to the Network

By Steve Rigney

Sooner or later, most road warriors need to connect their notebooks to the network or a desktop printer when they are in the office. The $399 JetEye *Net Plus*, from Extended Systems, connects an infrared-equipped notebook to your office LAN and desktop printer with a few mouse-clicks.

The JetEye *Net Plus* comes with all the software and hardware you need to connect to any Ethernet network running TCP/IP, IPX, or NetBIOS protocols; Extended Systems also offers a JetEye for Token-Ring networks. The system requires Windows 95 and only works with notebooks that have an IrDA interface. Hewlett-Packard Co. makes a similar device called the NetBeamIR, but it doesn't support direct printing, as the JetEye *Net Plus* does.

Although the JetEye *Net Plus* also offers up to 4-Mbps throughput, which is more than enough for most network applications, there aren't any notebooks that support this standard; today, notebooks are limited to the IrDA standard of 115-Kbps throughput. It only took us about 5 minutes to install the futuristic-looking device. The infrared transceiver is about the size of a small modem and includes a connector for the IR access point, printer, and 10Base-T or coaxial network cable; you can print to your printer while you're sending files to or receiving them from the network.

During evaluation, the JetEye *Net Plus* worked up to about 3 feet away from the notebook, as long as nothing was in the way. The only problem we found with the JetEye *Net Plus* was when we tried to connect our IBM ThinkPad 755 notebook to the network using the IPX protocol. We had IPX installed under Windows 95 and bound to the PC Card modem so that we could establish a remote-node connection from the road. Unfortunately, the JetEye *Net Plus* will not work with IPX if IPX is already installed and bound to another device in your notebook, such as a modem or an internal network adapter. The only solution is to remove the protocol from the other devices before you try to connect using the JetEye *Net Plus*.

FROM NOTEBOOK TO NETWORK: *The JetEye* Net Plus *can connect your notebook to the office LAN via an infrared link.*

If you are looking for a way to connect your notebook to your network without using any cables, the JetEye *Net Plus* is a great solution. But if your notebook doesn't have an IRDA interface, you don't run Windows 95, or you already have a PC Card network adapter, you should probably stick with the old-fashioned cable solution.

JetEye *Net Plus*. List price: $399. Requires: IRDA-equipped notebook, Microsoft Windows 95. Extended Systems, Boise, ID; 208-377-1906; fax, 208-327-5009; http://www.extendsys.com. *Circle 402 on reader service card.*

PDAS

Sharp ZR-5800FX Adds Backlight, Convenience, Spreadsheets, and PC Integration

By Jonathan K. Matzkin

Sharp Electronics Corp.'s $729 Sharp Zaurus ZR-5800FX Keyboard Enhanced Personal Digital Assistant advances the state of the art for PDAs on three fronts: It features better integration with desktop applications and beefed-up communications capabilities and adds a backlight so that its small screen is more readable under a variety of conditions.

The first thing that users will notice about the ZR-5800FX is that its switchable backlight illuminates its 5.25-inch-diagonal screen. Although not as bright as a good notebook backlight, the addition makes the ZR-5800FX usable in darkened rooms, though you'll have to get used to the green cast that the backlight imparts.

The ZR-5800FX also boosts internal storage to 2MB and supports PC Card modems while running on batteries (rather than on AC power only), but the 0.8- by 6.7- by 3.9-inch computer still fits onto a jacket pocket. The ZR-5800FX weighs a scant 14 ounces, and even with the 2,400-bps modem, the whole ZR-5800FX package tips the scales at less than 1 pound.

Equipped with PenWare's spreadsheet program, PenCell 2.0, the ZR-5800FX can open and work with Microsoft Excel 4.0 files. This eliminates the need to translate files when moving them between the ZR-5800FX and desktop systems running Excel. For example, we were able to import an Excel 4.0 file and move a group of cells to a new location via drag and drop with formulas intact. It's still not as full-featured or powerful as a desktop spreadsheet, but PenCell 2.0 lets the ZR-5800FX handle minor spreadsheet tasks.

PenCell 2.0 shares the look and feel of the other ROM-based ZR-5800FX applications. You access it by pushing a button conveniently located next to the display, and its toolbar is standard ZR-5800FX fare, including the ubiquitous "Send" icon, which initiates a file exchange with a PC or another ZR-5800FX. Integration with the ZR-5800FX's print and fax capabilities is the weak link; there is no way to print or fax an entire worksheet directly.

The ZR-5800FX's word processor supports rich-text attributes, allowing you to keep much of your document formatting intact. But expect to lose graphics and justification as well as headers and footers when you import a Microsoft Word document.

The ZR-5800FX really shines as a pocket communicator. It comes with clients for AT&T Mail, CompuServe, and pager access built in. The AT&T Mail client, which supports file attachments, is as feature-rich as many desktop mail clients. The CompuServe software offers mail, forums, and the Executive News Service. There are third-party clients for cc:Mail and MS Mail, with other software expected.

No PDA will take the place of a notebook. But when you can't take a full notebook with you, the Sharp ZR-5800FX does the trick.

BRIGHT LIGHT: *The ZR-5800FX's backlight allows the PDA to be used in many situations.*

Sharp Zaurus ZR-5800FX Keyboard Enhanced Personal Digital Assistant. Estimated street price: $729. Sharp Electronics Corp., Zaurus Division, Mahwah, NJ; 800-237-4277, 201-529-8200; http://www.sharp-usa.com. *Circle 401 on reader service card.*

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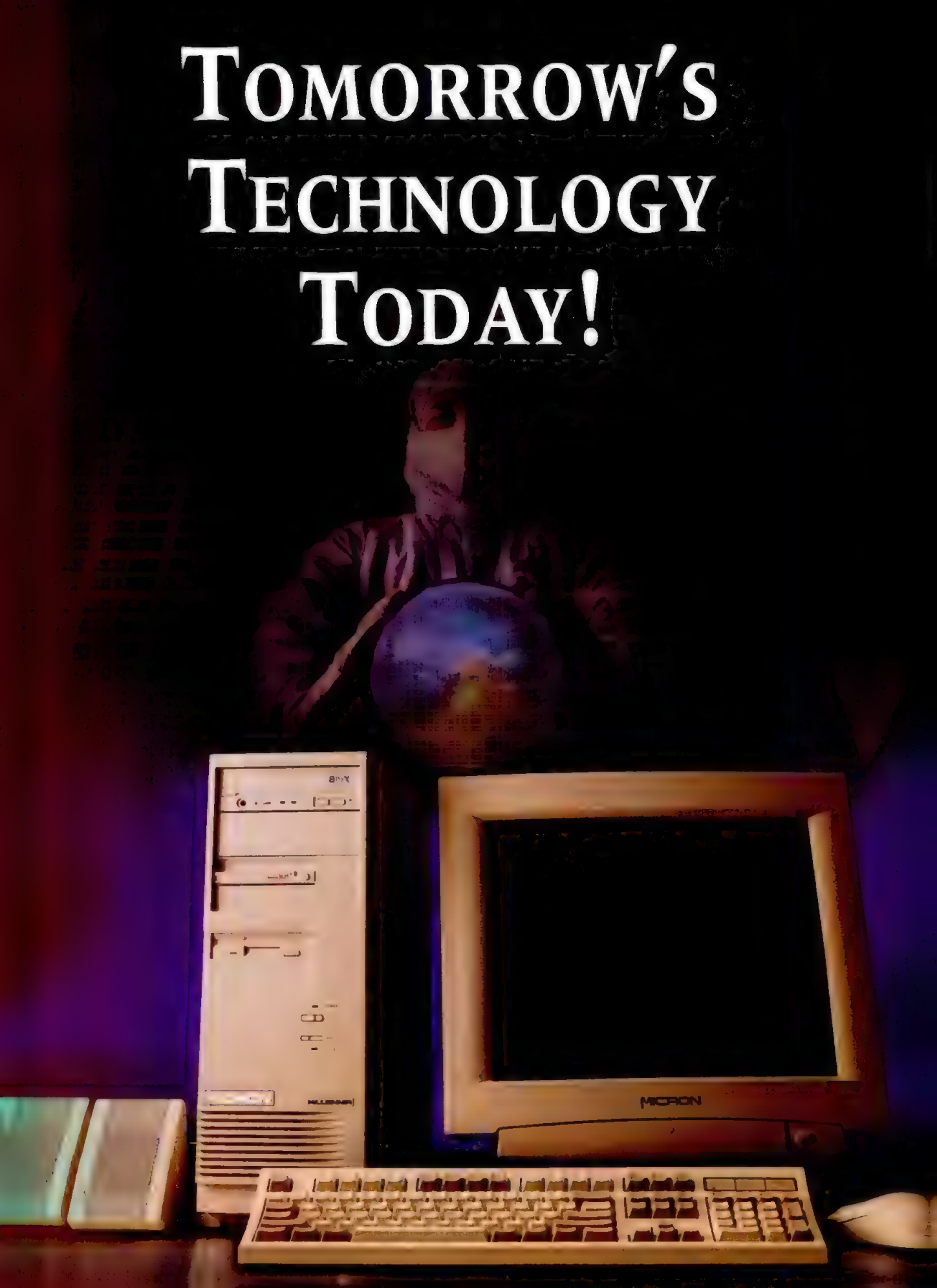

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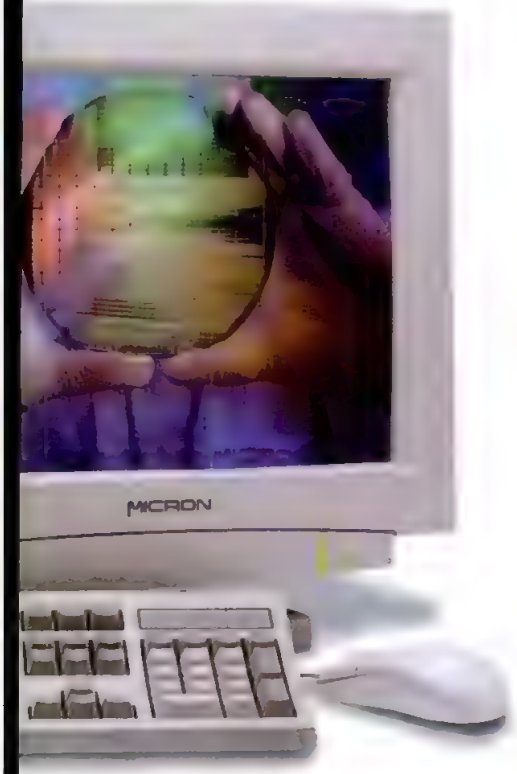

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"The Millennia is nothing short of the best all-around PC available on the market today."

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May 30, 1995
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"...we tested the latest PCs until they begged for mercy and found a no-compromise choice: Micron's Millennia P133."

—*PC Computing*, December 1995

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Exceptional speed, performance and reliability are just a few of the reasons Micron is a technology leader in PC design. From the award-winning PowerStation to the PowerServer SMP P266, Micron offers a complete range of dependable products to suit every need. When you're considering your next PC purchase, consider a Micron PC.

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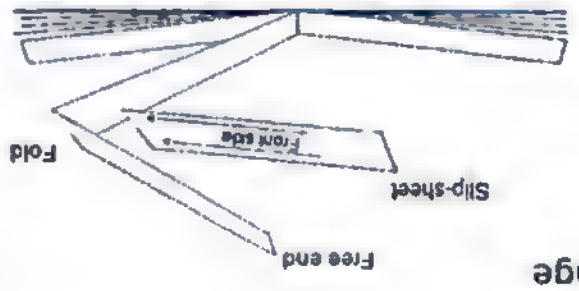

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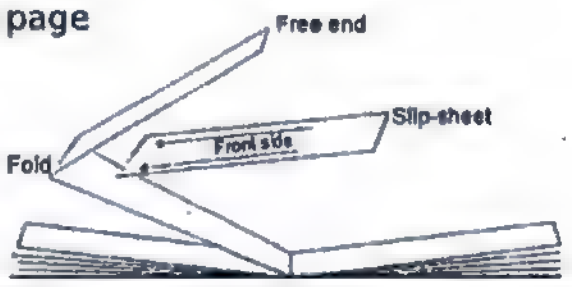

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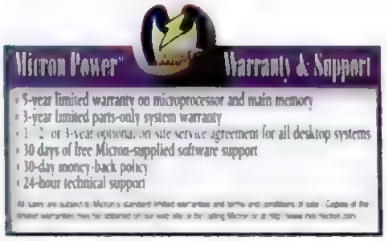

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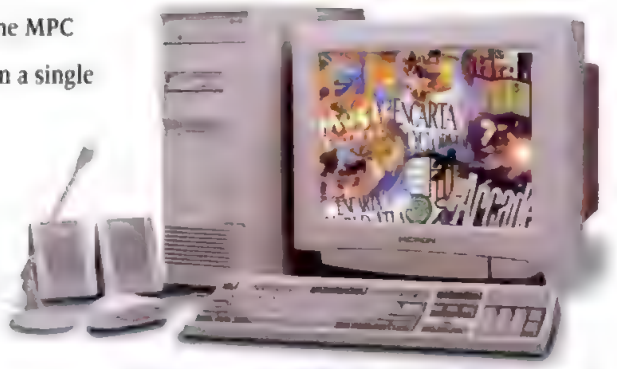

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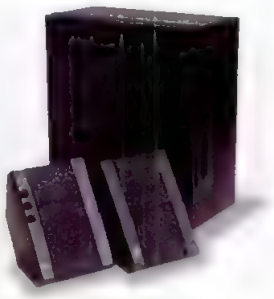

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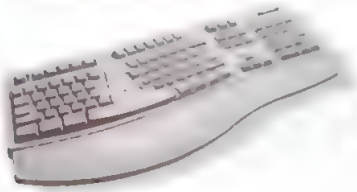

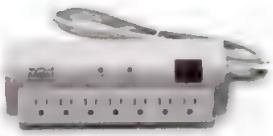

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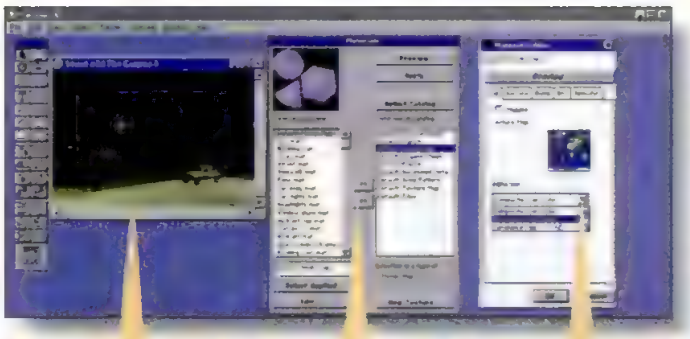
3-D SOFTWARE

Computing in the Third Dimension: Extreme 3D's Ease vs. Studio Max's Precision

As illustration programs move from the flat sheet into the third dimension, the result is not only a more realistic view of the world but potential confusion as to which 3-D program to use. Macromedia's $699 Extreme 3D and Autodesk's $3,495 3D Studio Max represent two extremes that demonstrate the range of possibilities.

Whereas Extreme 3D places emphasis on economy and ease, Studio Max breaks new ground in terms of depth, flexibility, and precision. Which program you choose to use to build your 3-D world depends as much on how realistic you want it to be as on how much time you're willing to spend constructing it.



The preview of the rendered scene appears quickly but without all the details.

Different materials can be combined in a variety of interesting ways.

The Material Editor lets you cover any object with a texture map.

MANY FACES: *Extreme 3D places a variety of editing screens before the user.*

EXTREME 3D

Macromedia's Extreme 3D starts with a standard set of 3-D tools and an uncomplicated interface and adds customization features, animation, and realistic previews.

All the expected tools (object links, 2-D shapes, and 3-D primitives) are in a vertical toolbar; everything else is accessed through pull-down menus. The program's status bar identifies the current tool and provides helpful technique instructions. The 2-D and 3-D drawing tools are easy to use and standard fare: There are tools for aligning, beveling, filleting, tapering, and trimming. In addition, deformation tools (bend, skew, stretch, taper, and twist) let you push and pull raw shapes. There's even a 3-D Bezier tool that makes easy work of producing compound curves.

Extreme 3D can import .WMF, .EPS, .DXF, FreeHand, or Extreme 3D formats. You'll have to wait until the next version for Macromedia's open plug-in architecture. What you will get is a collection of 36 models and 500 fonts. Third-party developers, such as Acuris and Viewpoint, offer libraries of Extreme 3D models.

Objects in Extreme 3D are defined according to spline and control-point geometries, which allows for powerful and flexible interactions. Beneath that level are the object's defining geometry (such as the circle and length of a column), its surface geometry (spline control points and tangents), and its polymesh geometry (control-point vertices of polygons). Be careful, because you can't undo a geometry change.

With six basic materials and three texture maps, Extreme 3D's Materials Library might seem small, but you can alter and combine materials. For instance, we used the Organic Magic feature to produce a mixture of two plastic-type materials. With Mondo Map, we were able to wrap bitmapped images around objects and define the surface's bumps and reflections. The included Wraptures CD supplies hundreds of textures, environments, and bump maps.

Lighting effects in Extreme 3D include ambient, distant, omnidirectional, and spot. Each of the effects has controls for color, falloff, dust cone, shadow casting, and intensity.

Everything in a scene can be animated, including material transitions, lights, and shape changes. Animated sequences can be defined and created either interactively in the workspace or by editing the objects and their tracks in the Animation Score dialog box. We were also able to turn any object into another object's path. For example, we made a starburst travel along a string of text while spelling out a name. The biggest shortcoming is the lack of sound tools; you'll need to export the file to add audio.

When it's time to render your 3-D creation, Extreme 3D's Interactive Renderer shows an approximation of your work in progress via Gouraud shading but doesn't show all the details. You can select from among various render styles (Bounding Box, Faceted Wireframe, Fast Wireframe, Shade, or Smooth) for each object in a scene, but no object's interactive rendering style can be more complex than the scene's overall setting.

The Final Render to Screen process produces a preview of the scene that includes shadows, lights, dust cones, and such. It automatically uses Gouraud shading for 8-bit color depth and the more detailed Phong shading for 32-bit work. For the sake of speed, Extreme 3D doesn't use ray tracing, which is generally considered more realistic but is slower.

Extreme 3D can speed the rendering process by linking networked computers. But there are limitations: .AVI animation rendering can't be distributed, and a mixed environment of PCs and Macintoshes can only produce Targa file output, while a PC-centric network can produce .BMP or Targa files.

Taking 3-D to the Web

Although 3D Studio Max is a robust, full-featured production environment, plug-in technology takes it a step further.

Kinetix, for example, is preparing to ship Character Studio, which consists of two plug-ins developed by Unreal Pictures. Biped allows you to move any two-legged character, and Physique lets you animate bulging muscles on your creations.

A brief sampling of third-party plug-ins includes 4Division's natural-media painting tools (*http://www.4division.com*); Animetix Technologies' conversion routines for game developers working with Microsoft's Direct3D, Sony PlayStation, and Sega Saturn formats (*http://www.animetix.com*); and Sand Blaster, a next-generation particle system from Digimation (*http://www.digimation.com*).

On the downside, all of the IPAS routines developed for 3D Studio Release 4 won't work with Studio Max. Instead, Kinetix offers the best of both worlds: It is allowing users to migrate to Studio Max while still maintaining a working version of Release 4 on their systems. —*LS*

Extreme 3D is a fast and powerful program that is certain to become even more versatile in future versions.—*Daniel Grotta and Sally Wiener Grotta*

Extreme 3D. List price: $699. Requires: 16MB RAM, 20MB hard disk space, Microsoft Windows 3.1, Windows 95, Windows NT. Macromedia Inc., San Francisco, CA; 800-326-2128; fax, 415-626-0554. http://www.macromedia.com. *Circle 407 on reader service card.*

3D STUDIO MAX

The original release of Autodesk's 3D Studio proved that you can use a PC for professional modeling, rendering, and animation (First Looks, January 24, 1995). Autodesk's recently formed Kinetix subsidiary takes that concept a step or two higher on the 3-D food chain by moving 3D Studio Max from the DOS environment into Windows NT.

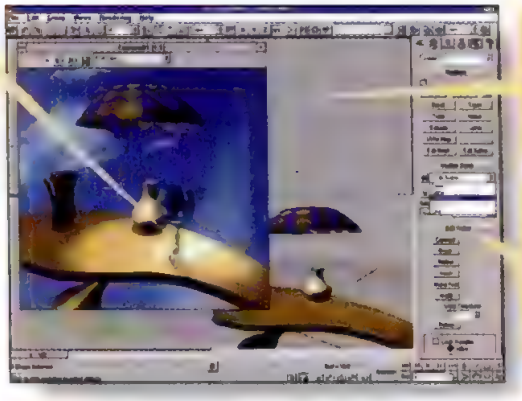
Studio Max delivers maximum performance and control over the creative process. The program's new graphical interface and integrated environment combine functions that were previously in discrete modules (such as the 2D Shaper, 3D Lofter, 3D Editor, and Keyframer) into a common workspace, which fosters interaction and synergy among them.

The program has come a long way. For example, creating a table setting in 3D Studio required each object to be created individually, followed by the importation of the various elements into the 3D Editor for sizing and positioning. By contrast, Studio Max lets you simply put a localized grid on the tabletop and create bowls, glasses, or plates in position.

The integration of modeling and keyframing operations also means that many core functions can be animated. You can deform an object's shape over time, for instance, using standard geometric modifiers (such as Bend or Twist). All it requires is that you click on the Animate button and create the appropriate keyframes.

Studio Max keeps track of the entire history of each object in an editable file called the Modifier Stack. You can scroll back through the stack at any time and return the object to an earlier state. If you change an object's attribute or parameter, the new values will reflow through all of the subsequent modifications you've made.

For example, we used the Modifier Stack to change the taper of a cone and to reorder the stack commands so that the new object would be twisted before it was bent, not after. Beyond accommodating changes of heart, the Modifier Stack lets you move between 2-D and 3-D geometries. Just because you've lofted a 2-D shape into a 3-D object doesn't mean you can't go back and edit the original splines.



The glass appears as a lathed 3-D object in the rendered view.

The glass appears in the viewport in an editable spline form.

The Modifier Stack lets you move backward through an object's history.

SINGLE FACE: *By pulling all the various elements together in one interface, Studio Max becomes an easier program to understand and use.*

You can now push and pull 3-D objects as though they were lumps of clay. Start by defining the surface in Patch Modeling mode by using Bezier curves and a control lattice. Conceptually similar to 2-D curve editing, this process lets you use points and tangent handles to reshape 3-D objects in Studio Max. Then move into Edit Mesh mode, where basic geometry (edge, face, and vertex) is controlled.

Dramatic and realisitc animation effects are possible with new classes of objects. For example, dust, rain, and snow can be generated automatically by using the Particle Systems function. You can adjust the particles for shape, size, and speed. Special effects, such as explosions, waves, and winds, are created with Space Warps. These objects function as force fields that can deform the geometry of objects or influence the behavior of particles.

When you render a scene, you'll find the new Volumetric Light function can produce sunlight streaming through clouds or a campfire's glow. Unlike postproduction filters, which are applied to 2-D rendered images, volumetric lights are based on 3-D data.

Refinements Kinetix made to the Materials Editor mean that the objects themselves can also be rendered with surfaces that are more complex. You can also render different types of maps to the same object (such as bump, diffuse-texture, and opacity maps). For example, we created a double-sided material whose inner and outer faces were rendered with different surfaces.

Although you could always fine-tune the motion of objects in an animation using 3D Studio's time line, Track View, you can now use Out of Range controls to loop the action; Function Curves let you moderate the loop intelligently over time. We created a pair of keyframes that bounced a ball once, repeated the segment ten times, and diminished the bounce until the ball came to rest.

The advanced functions offered by Studio Max are computationally intensive: You'll need at least a fast Pentium processor, 32MB of memory, and a 100MB swap file.

3D Studio Max's network-rendering function now utilizes the TCP/IP protocol. Indeed, as a VRML-compliant tool, Studio Max will work in tandem with a soon-to-be-released sister product, Hyperwire—a visual authoring tool for 3-D Java applications. But the real future of this program lies in the imagination of its users.—*Luisa Simone*

3D Studio Max. List price: $3,495. Requires: 32MB RAM, Microsoft Windows NT 3.51, CD-ROM drive. Kinetix, a division of Autodesk Inc., San Rafael, CA; 800-225-6106, ext. 441; http://www.ktx.com. *Circle 408 on reader service card.*

3-D WORLD: Digimation's World Wide Web site contains many add-ons.

Hey, look. Another software ad promising to get everyone working together in complete harmony.

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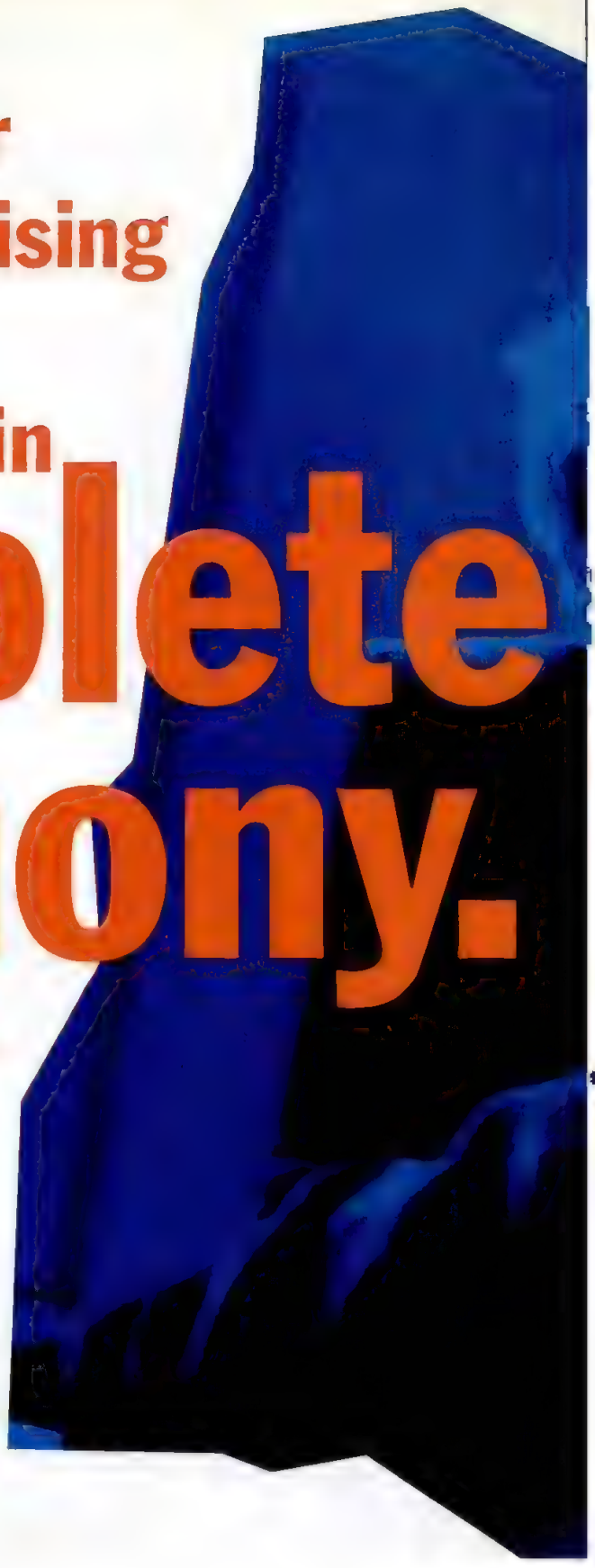

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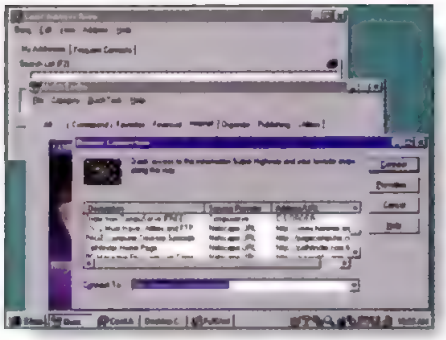
SUITES

Does Corel WordPerfect Suite Leave Office And SmartSuite in the Dust?

By Edward Mendelson

WordPerfect is back, and under Corel's corporate banner, it's well armed to battle against Lotus and Microsoft Corp. in the application-suite arena.

The first 32-bit version of WordPerfect for Windows is the centerpiece of Corel WordPerfect Suite 7, a $449 powerhouse of an application suite that includes vastly improved 32-bit versions of Quattro Pro and Presentations, a unified address book and control center, natural-language help, and a cornucopia of Corel graphics goodies. Despite a few rough edges, the package integrates with Windows 95 better than Microsoft Office does, and it offers more Internet-readiness than Lotus SmartSuite or Office.



INTEGRATED: *You can run Corel WordPerfect Suite 7 from icons on the Taskbar that launch applications, run macros, or browse the Web.*

SUITE DAD

Holding the suite together is the new Desktop Applications Director (DAD), which sits in the Windows 95 system tray and doesn't take screen space away from applications. A range of supplied QuickTask macros operate across the entire suite and let you create World Wide Web sites, track stocks, consolidate expense reports, or perform any one of two dozen complex tasks.

You can create your own tasks in the suite's shared macro language—a feature that's still not available in Office or SmartSuite. A Software Developers Kit for macros comes on the program's CD-ROM. Other DAD features include quick access to favorite Web sites, and WordPerfect Suite installs your Netscape Navigator bookmark page by default. If you don't have Navigator, the suite can install it as well as a copy of AT&T WorldNet Service.

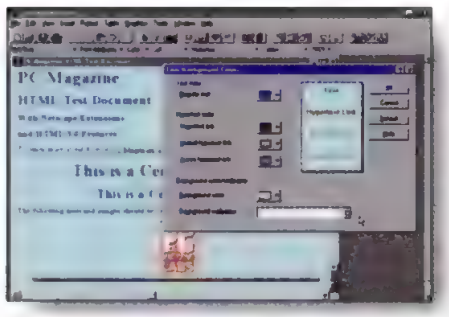
WordPerfect 7 uses the Version 6.*x* file format and won't require retraining to master. New features that fit neatly into the earlier menu structure include an Internet publisher that walks you through the steps needed to create an HTML file, converts the current document into HTML, or converts an HTML file into WordPerfect format.

To create a link from your word processing file to a Web page, simply display the page in Navigator and press a few keys in WordPerfect. Your pages can include such HTML 2.0 features as tables, but there are no tools for creating an HTML form. You can import graphics from virtually any bitmapped or vector format or scan them in directly from any Twain-compatible scanner; all are transparently converted into .GIF or JPEG formats.

New convenience features include an optional hot spot next to the current graphic, paragraph, or table with appropriate formatting options so you don't have to dig through multiple menus. Optional gridlines help make sense of tables and columns, and a new tab-setting icon lets you see exactly where you've inserted new tab rulers. While you move through a document with the mouse, a gray shadow pointer shows where the cursor will move next, but you'll have to wait for a future release if you want to turn off this feature.

Spell-checking optionally occurs on the fly, and the spell-check dialog box is now a separate panel at the foot of the screen instead of a box that floats annoyingly over your text. Annotations are color-coded to indicate which reviewer created them. As in Microsoft Word, you can use the Tab key to indent a paragraph.

WordPerfect retains its high-end lead and is still the only word processor that can double as a credible desktop publishing package, complete with an option to wrap text around irregular graphics. The style and outline features remain needlessly confusing, and you still can't customize the bullets-and-numbers styles. The archaic code-based equation editor hasn't changed. Some features, such as the ability to record a macro that pauses for input, were dropped.



WEB PUBLISHER: *WordPerfect Suite 7 edits HTML files in WYSIWYG view with easy access to formatting options.*

WordPerfect's available tables include 100 spreadsheet functions, default styles, and automated quick formatting and can now include diagonal lines through one or more cells; cells can be rotated in 90-degree increments. For serious spreadsheet functions, Quattro Pro 7 now includes a dazzling Formula Composer that displays equations in a tree-structured form for quick debugging. Data manipulation remains more awkward than in Microsoft Excel or Lotus 1-2-3, but mapping features are now included, and cells can reference Internet addresses.

The Presentations program shares much of its code with the graphics features in the rest of the suite. You can use the latest Internet graphics, such as the Portable Network Graphics format, and the program includes dozens of transitions and animation controls.

SINGLE ADDRESS BOOK

The suite integrates the separate address books for envelopes and templates into a single elegant entity that lets you organize your contacts in tabbed multiple booklets. Envoy, an electronic document package, is accessible from menus throughout the suite, so you can publish files for use with the standalone Envoy viewer or the Envoy plug-in for Navigator.

Also tossed into the suite are CorelFlow, Dashboard, and Sidekick, although none are integrated. The included copy of Inso's QuickView Plus will prove the most useful; its file-viewing utilities integrate with the Windows 95 Explorer and many other applications. In June, Corel will ship the $695 Office Professional package, which adds the database Paradox 7, the PIM InfoCentral 7, and a client license and software from GroupWise. The drawing module from CorelDraw will replace CorelFlow.

Under Corel's ownership, WordPerfect again has a future, and Corel WordPerfect Suite 7 is an impressive and encouraging new beginning.

Corel WordPerfect Suite 7. List price: $449 (upgrade $129). Requires: 8MB RAM, 80MB hard disk space, Microsoft Windows 95. Corel Corp., Ottawa, Ontario, Canada; 800-772-6735; http://www.corel.com. *Circle 428 on reader service card.*

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DIGITAL PHOTOGRAPHY

Polaroid's PDC-2000 Takes Sharp Digital Pictures—with Some Effort

By Daniel Grotta and Sally Wiener Grotta

Polaroid Corp.'s $3,695 PDC-2000/40 is a sleek, slim, well-built digital camera that looks like a spaceship, feels like a 1960s 8-millimeter (mm) movie camera, and extends the state of the art for filmless photography, but it can be awkward to use.

On the front of the camera are the lens, viewfinder, strobe flash, and auto-focus sensor. Although horizontal shooting felt comfortable and natural, shooting in the vertical mode required holding the camera in what felt like an upside-down position, because the viewfinder is below and to the right of the lens. That's so the flash will be above and not below the lens. In addition, the camera's control buttons are awkwardly placed and can be confusing to use.

The PDC-2000's thumbnail-size charge-coupled device (CCD) target contains 1 million horizontal pixels to help eliminate color aliasing. When the RGB color channels are saved as an image file, however, the pixels become square, and the image is therefore sharper than other digital cameras'. And to improve light transmission, Polaroid opted for pastel rather than solid-color RGB filters. The camera has an ASA rating equivalent to a film speed of 100.

The net effect is an uncompressed file size of 1MB—40 times as much raw data as images from the Casio QV-10 (First Looks, October 24, 1995). You have the choice of either saving a photo as a 1.44MB 800- by 600-pixel file or interpolating it into a 5.76MB 1,600- by 1,200-pixel file.

For optimum exposure and color balance, the user can select the type of lighting (daylight, incandescent, or fluorescent), choose the flash mode (full, fill, or no flash), and even compensate for backlighting. But there is no general exposure-compensation feature. And though the flash carries up to 15 feet, it doesn't have a preflash exposure to eliminate "red eye" and tends to overexpose subjects closer than 6 feet. The biggest disappointment was the lack of a connector for attaching auxiliary or studio strobes.

There's a simple labeling system for annotating each image with up to ten alphanumeric characters. Although this works reasonably well, there's no provision for interfacing with a PC or PDA to download a shooting session's details.

Polaroid claims that the PDC-2000's SCSI-2 interface can transfer 800- by 600-pixel images in as little as 6 seconds and 1,600- by 1,200-pixel images in 9 seconds. On our 486DX2/66 test system with 16MB of memory, we were able to acquire 800- by 600-pixel images in about 44 seconds; it took 5 minutes 9 seconds to transfer a 1,600- by 1,200-pixel image.

The weak link is Polaroid's Twain interface, which lacks any image-editing or -correction tools, except for an instant-rotation feature. You can elect to capture one, several, or all images to the screen or to disk (but not to both simultaneously) at either resolution.

One particularly valuable feature for users who need to shoot a series of images from a stationary position is the ability to display real-time black-and-white preview images from the camera to the computer monitor. When the subject is ready, you take the picture by clicking your mouse. Our test computer updated the display approximately every 2 seconds.

Several unfortunate engineering decisions mar the PDC-2000's design. One was using sonar rather than infrared auto-focus. The sonar sensor focuses on the largest object in the middle of the viewfinder. If you want a specific part of the picture to be sharp, you must first frame your subject in the middle, press the shutter button halfway to lock the focus, and then move the camera to the picture-taking position. In addition, focusing is done by adjusting the position of the CCD—not the lens—and the camera's stepper has 50 preset positions.

Rather than use through-the-lens viewing, Polaroid opted for a mediocre optical viewfinder with neither parallax correction nor a macro indicator. The battery compartment's door can pop off easily, spilling the four rechargeable AA batteries. The 11-mm lens has a fixed focal length and no zoom, and the only interchangeable lens available is a $199 17-mm portrait lens.

The PDC-2000 doesn't give users any way to set aperture and shutter speed manually or any choice of metering and focusing modes. There's no PC Card slot, so all images are stored internally. Once the 40MB hard disk is filled, the images must be uploaded to a computer before the next shot.

Despite the PDC-2000's shortcomings, its digital photos were sharp, with vivid colors that reproduced a tonal range rich with detail. In fact, they are among the best-looking images produced by the filmless cameras under $23,000 that we've tested.

Polaroid PDC-2000/40. List price: $3,695. Requires: 8MB RAM (16MB recommended), DOS 5.0 or higher, Microsoft Windows 3.1 or later, ASPI-compliant SCSI adapter. Polaroid Corp., Cambridge, MA; 800-816-2611, ext. 868; http://www.polaroid.com/. *Circle 404 on reader service card.*

FIRST LOOKS PLUS

From July 8 to 12, you can go online to discuss the Polaroid PDC-2000 with reviewers Daniel Grotta and Sally Wiener Grotta and Polaroid product executives. Type GO EDITOR on CompuServe to join the discussion.

SPIN, SPIN, SPIN: *The PDC-2000's interface lacks basic image-editing or -correction tools, but it allows you to rotate images.*

EARTH TO POLAROID: *The Polaroid PDC-2000 might resemble a spaceship, but it takes sharp and colorful photographs.*

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INTERNET SOFTWARE

PC Broadcast News: PointCast Delivers over the Internet

By Cade Metz

Continuous news delivery à la CNN and CNBC has arrived at the desktop in the form of the PointCast Network. The PointCast Network provides up-to-the-minute headline stories, weather maps, sports results, and other information. Unlike cable TV, the PointCast Network lets you personalize the content.

The PointCast Network—whose client software can be downloaded at no cost from *http://www.pointcast.com*—delivers news to clients via the Internet. The PointCast client can be used over an office network or via a dial-in modem connection. Unfortunately, this news-retrieval process can be excruciatingly slow and a significant drain on system resources. Whether you have a T1 link or are dialing in by modem at 28.8 Kbps, expect lengthy delays.

PointCast news can be viewed through one of two windows: SmartScreen or ChannelViewer. SmartScreen is a colorful animated interface that is triggered after a preset period of inactivity. SmartScreen launches a kinetic collection of headlines, sports scores, and stock tickers.

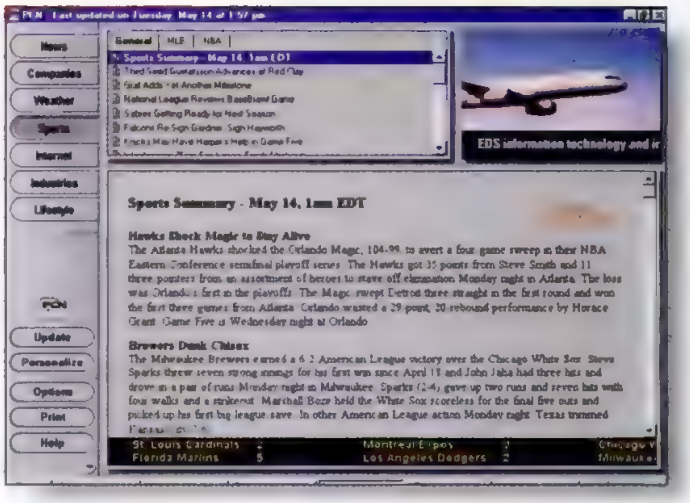
Click on a headline of interest and ChannelViewer offers the story's full text. ChannelViewer, which can also be accessed directly, contains five panels for filtering, organizing, and reading your news. One panel lists PointCast's collection of "channels," encompassing such subject categories as Companies, Industries, Lifestyles, News, and Sports. A list of the highlighted channel's current stories is displayed in the second panel. Selecting a story will bring up the full text of that story, along with graphical news nuggets. A control center allows you to update your news cache and print stories.

PointCast's Personalize button allows you to control the makeup of each channel. If you check only the MLB and NBA box scores under the Sports channel, then you won't receive NASCAR or NHL results. Or you can set up an IBM stock ticker while ignoring the rest of the market.

Showing that even on the Internet there's no free lunch, the PointCast Network displays advertisements. These ads are notable because of the mildly entertaining animations they provide. Clicking on an ad, choosing a Web hypertext link in a news story, or accessing the Internet channel turns ChannelViewer into a Web browser that immediately jumps to the appropriate page.

The PointCast Network is currently serving news to about 200,000 clients an hour. Los Angeles and New England residents can now receive the full text of the *Los Angeles Times* or the *Boston Globe*, respectively, while all users can tap into a Pathfinder channel that serves up news from *Money*, *Time*, and *People*.

Don't just read the news, make your own broadcast—with the PointCast Network.



EXTRA, EXTRA: *PointCast's interface lets you customize a news feed.*

PointCast Network. List price: Free download. Requires: 8MB RAM, 10MB hard disk space, Microsoft Windows 3.*x* or Windows 95, direct or dial-up Internet connection. PointCast Inc., Cupertino, CA; 408-253-0894; fax, 408-253-4058; http://www.pointcast.com. *Circle 427 on reader service card.*

WORLD WIDE WEB AUTHORING

Web Design Tools for the Graphically Challenged

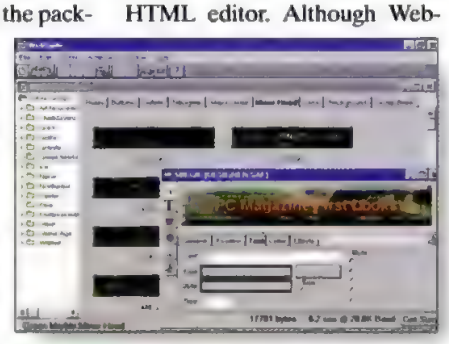
By Charles Lin

DigitalStyle Corp.'s $199 WebSuite Starter Edition can help you create Web pages without the help of a graphics artist by using the package's excellent graphics and design tools.

WebSuite is aimed at Web masters and Web designers who are responsible for a company's intranet or Internet presence. You can create impressive pages using WebSuite's sizable collection of graphics for backgrounds, bullets, buttons, heads, icons, rulers, and other design elements.

The Starter Edition contains five style groups. This summer the company will release a $99 Standard Edition with 10 style groups and a $199 Designer Edition with 25 different style groups. DigitalStyle will also reduce the cost of the Starter Edition.

Although it's not an HTML editor, WebSuite works with any HTML editor. Although WebSuite can edit all of your graphical components, it's not a full-featured image-editing program. The Text tool lets you add text with realistic shadowing effects to icons, and the Transparency tool allows the background to be visible through the graphical elements.



WEB HELPER: *Even novice Web designers can create attractive pages with WebSuite.*

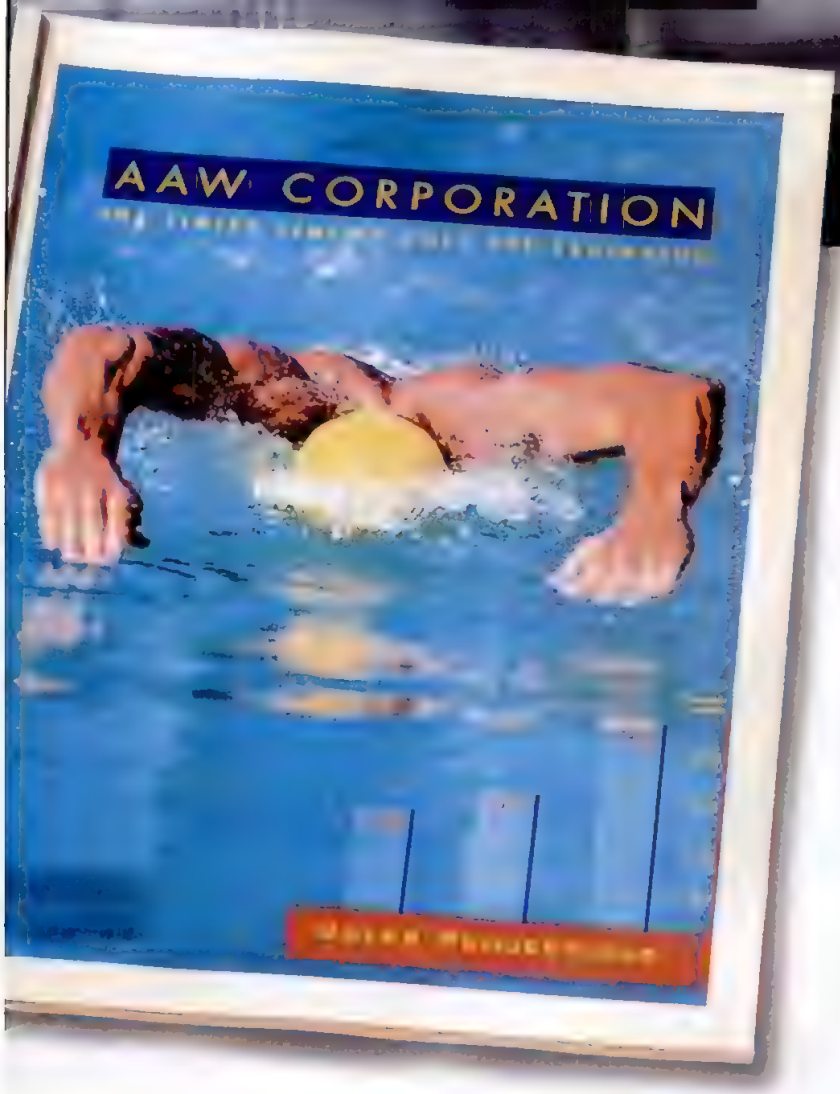
Another convenient feature is WebSuite's ability to import many popular image formats and then convert those images to the 256-color .GIF format. Imported graphics can be placed in a component with either position coordinates or with a relative position.

WebSuite's Get Size tool will show you the component's size and the time required to download it using a 28.8-Kbps modem.

WebSuite requires two steps to place an image, and the editor only allows the user to create either oval or rectangular objects. Nevertheless, WebSuite's easy-to-use interface allowed us to craft a variety of distinctive Web pages with ease, and the program is an excellent addition to the Web toolbox.

WebSuite Starter Edition. List price: $199. Requires: 8MB RAM, 4.4MB hard disk space, Microsoft Windows 3.*x*, Windows 95, Windows for Workgroups, Windows NT. DigitalStyle Corp., San Diego, CA; 800-541-1175, 619-673-5050; http://www.digitalstyle.com. *Circle 426 on reader service card.*

In the past, winning new business was a black or white proposition.



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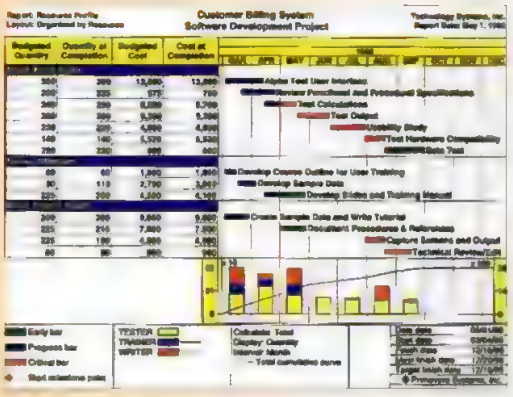

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CIRCLE 148 ON READER SERVICE CARD

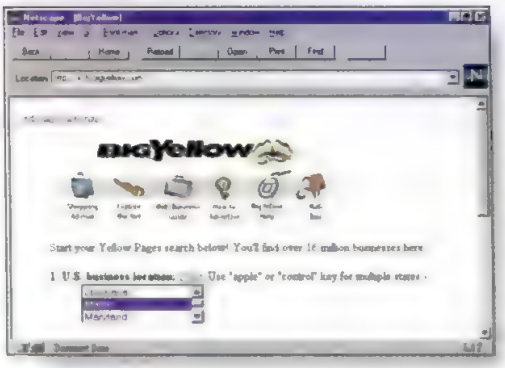
WORLD WIDE WEB SITES

Web Yellow Pages Let Your PC Do the Walking

By John Morris

Internet-based telephone directories are prime examples of things that can be better on the World Wide Web than on your bookshelf. Today's best online directories have no geographic limitations, can be searched based on a wide variety of criteria, and can be interactive, allowing businesses to display ads or edit their listings online.

Not surprisingly, the Yellow Page industry, already a $10 billion-a-year business, is flocking to the Web. Here are four of the most interesting ones.



BIG BUSINESS: *NYNEX's Big Yellow has 16.5 million company listings and a powerful search engine.*

BIG YELLOW

NYNEX's national index of 16.5 million listings, Big Yellow (*http://s16.bigyellow.com*), is a comprehensive directory, a resource on electronic commerce, and an easy entrance ramp to the Internet for businesses.

To begin searching Big Yellow, you select one or more states and a business category. You can refine the search by entering a business name, city, ZIP code, or street name, or even an area code. When you begin the search, Big Yellow displays any business types similar to the category you entered and allows you to choose up to five categories. A search on "seafood in Maine," for example, turned up everything from Aquariums to Tropical Fish. Fortunately, we were able to refine the search parameters and find the restaurant we were looking for. Big Yellow also provides dynamic Web links for businesses.

CYBER-SAVVY: *You can search for telephone listings or Web sites with SuperPages.*

Shop Tips lists the 50 most-requested categories. Click on Airlines and you receive tips for getting the best airfare, as well as links to airline and travel-related sites. In the unlikely event you can't find what you're looking for in Big Yellow, the site provides a link to InfoSeek, a search engine.

Big Yellow's Business Guide offers helpful information on developing a cost-effective online strategy and links to Web commerce sites.

SUPERPAGES

GTE Corp.'s SuperPages Interactive Services (*http://superpages.gte.net*) combines Interactive Yellow Pages with a Business Web Site directory. GTE claims a database containing 11 million listings and 60,000 commercial sites. SuperPages excels with slick graphics, an intuitive interface, and a powerful search engine.

Not only does SuperPages allow you to search by category, address, and phone number, but you can also refine your search based on the hours open for business or number of years in business. Searching based on keywords, such as "free delivery," can be a powerful tool, but unfortunately, this more detailed information is not part of SuperPages' basic listing. Instead, the directory relies on businesses to go online and fill out a form to create a Fact File (free for the first six months). Since most listings don't have a Fact File, searching for keywords can be frustrating.

SuperPages provides a list of the categories that meet your criteria and the number of listings in each category. By default, SuperPages displays businesses with paid advertisements first, but you can also sort the listings according to business name or city.

The Business Web Site Directory lets you search by company or category. We found the Directory useful for finding business sites in major categories (airlines, Internet-access providers, and so on), but it didn't offer the breadth of major search engines such as InfoSeek and Yahoo!.

CENTRAL SOURCE

Based on data supplied by American Business Information, Central Source Yellow Pages (*http://www.telephonebook.com*) claims to have listings of "virtually every business in the U.S.A." You can search its listings by category, business name, or phone number.

You must enter a state abbreviation to perform a search, and we weren't able to search across several states or the entire country simultaneously. Central Source provides the address, phone number, category heading, and Standard Industry Classification (SIC) code for each listing.

A simple form lets you add a new business location, edit a listing, or insert a dynamic link for free. Central Source also provides links to useful sites such as those for airlines, reference works, and overnight shipping services.

We were impressed with Central Source's well of data, but the site could use search options that are more sophisticated. The lack of graphics and the simple layout may appeal to those using dial-up access or browsers other than Netscape Navigator or Microsoft Internet Explorer, but the interface has an unpolished look and feel.

WYP.NET

One of the most innovative Yellow Page directories is the World Yellow Pages Network, or wyp.net (pronounced "whip-net"; *http://wyp.net*). Wyp.net provides both Yellow and White Pages, and the company claims to have 105 million listings. A separate Four11 directory contains 4.7 million e-mail addresses.

Each listing is given a Web page with a unique ID number, which doubles as its URL. You can create a rudimentary searchable page for your business, called a Virtual Office, at no charge. The Virtual Office is password-protected and includes the business's name, address, phone and fax numbers, Yellow Page headings, SIC headings, and keywords, as well as up to 300 words of text. We created a serviceable page for a fictitious firm in a matter of minutes.

A bonus is wyp.net's Meta USA Yellow Page search, which provides links to other online directories as well as utilities for determining ZIP+4 codes, SIC codes, and international area codes.

Wyp.net lags behind some sites in terms of basic features. For example, you can search by business name, phone number, or ZIP code but not by keyword or even Yellow Page heading.

With all this information available at the touch of a few keys, all you have to figure out is what to do with those old printed directories.

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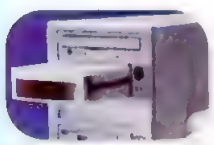

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CIRCLE 079 ON READER SERVICE CARD

WINDOWS 95 UTILITIES

Two New Takes on File Compression for Windows 95

By Barry Simon

Drag and File Gold 2.0 and WinZip 6.1 are both compression and file management utilities, but each takes a different approach to the Windows 95 environment. Canyon Software's $55 Drag and File Gold 2.0 combines the familiar File Manager interface with Windows 95 features. Nico Mak Computing's $29 WinZip employs wizards and automates many of the tasks associated with file compression.

DRAG AND FILE GOLD 2.0

Drag and File Gold 2.0 will appeal to those fond of the Windows 3.1 File Manager, as well as those who have to manage a lot of compressed files. Drag and File supports long filenames and takes advantage of many of the other features of the Windows 95 Explorer. For example, if you right-click on a filename in a Drag and File window, you get the full context menu for the correct file type.

Drag and File displays .ZIP files, as well as the Internet-centric .TAR and .GZ files, as folders in the tree portion of the program's window.

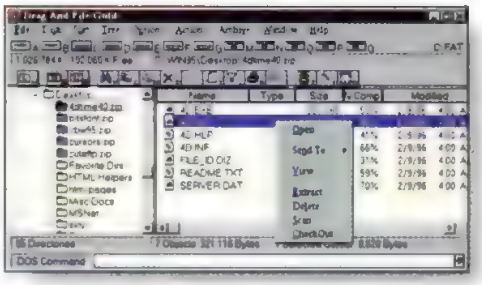
The program contains a drive bar that displays icons for each drive, a DOS command-line version (a special version of Smiler Shell), and a virus checker from Stiller Software. After we reviewed Version 2.0, Canyon Software released Version 2.2, which adds an "Explorer View" option for displaying all the volumes and folders in the program's tree view.

WINZIP 6.1

WinZip has a reputation as the slickest and easiest to use of all the Windows 95 .ZIP file management utilities. With its WinZip wizard, Version 6.1 brings WinZip simplicity to a new level.

During installation, WinZip adds any directory with "download" in its name and, optionally, directories with .ZIP files to its Favorites list, so just about any file you recently downloaded is likely to be included. The files are displayed by date modified, with the most recent ones at the top.

The WinZip wizard will then unzip the file to a new directory, and if there is a SETUP.EXE or INSTALL.EXE file, WinZip automatically runs it. The program can be configured to run the wizard whenever you double-click on a .ZIP file, so that downloading and installing programs inside .ZIP files becomes effortless. Though there is no wizard for creating .ZIP files, a tutorial helps users with file compression.



FILE MANAGER PLUS: *Drag and File Gold lets you manage and view archived files.*

Version 6.1 retains WinZip's tried-and-true interface and adds some minor enhancements and an "Open with WinZip" command to context menus for self-extracting zipped .EXEs.

With Version 6.1, WinZip continues to be a must-have utility for all users.

Drag and File Gold 2.0. List price: $55. Requires: 4MB RAM, 2MB hard disk space, Microsoft Windows 95. Canyon Software, San Rafael, CA; 800-280-3691, 415-453-9779; http://www.canyonsw.com. *Circle 405 on reader service card.*

WinZip 6.1. List price: $29. Requires: 4MB RAM, Microsoft Windows 3.1, Windows 95, Windows NT. Nico Mak Computing Inc., Bristol, CT; http://www.winzip.com. *Circle 406 on reader service card.*

CONTACT MANAGEMENT SOFTWARE

Maximizer 3.0is: Flexible, Competent Contact Management

By Kathy Yakal

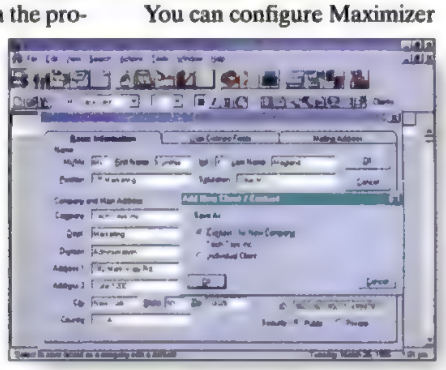
The $149 MultiActive Maximizer 3.0is for Windows 95 retains the look and feel of one of the oldest and most popular contact managers but adds new Internet hooks. (The "is" stands for "Internet-savvy.")

Maximizer 3.0is runs under Windows 3.*x*, Windows 95, or Windows NT. Maximizer's popularity is based largely on the program's flexible approach to handling contacts. For example, you can set up core records for clients (companies or other organizations) and link an unlimited number of individuals (contacts) to them.

A tabbed file holds all the fields you'll need, including multiple address fields. You can also set up an unlimited number of user-defined fields (UDFs) containing table, alphanumeric, date, or numeric data or any combination. UDFs can use customized drop-down lists, and they are searchable. Some are predefined.

Maximizer 3.0is' calendar and task management capabilities match those of the best contact managers. You can attach scheduled items and to-do lists to contacts or assign them to your personal hotlist, prioritize tasks, and find time for scheduling one-time or recurring events.

You can configure Maximizer 3.0is to enter such events as phone calls. And when you've completed an activity, Maximizer 3.0is asks if you want to schedule a follow-up.



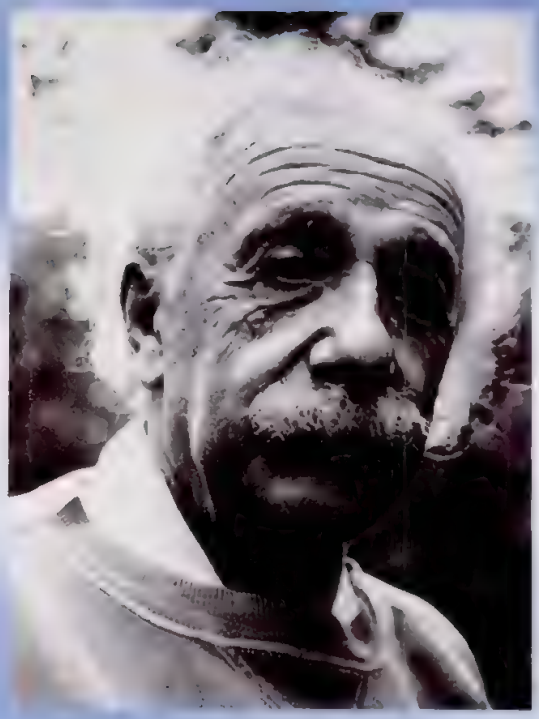
MAXIMUM FLEXIBILITY: *Maximizer 3.0is lets you add multiple contacts to a company.*

Billed as the first Internet contact manager, Maximizer 3.0is allows you to tap into the new Eagle database to find and download information on new contacts. The database, which can be accessed at *http://www.maximizer.com*, contains information on 10 million businesses, supplied by American Business Information. You can search the records by address, area code, name, number of employees, or ZIP code and then download the results directly into Maximizer 3.0is.

Although you can tile multiple windows to view several aspects of a contact's information simultaneously, this feature doesn't work very well. On the whole, Maximizer 3.0is's performance on common contact management tasks was fine, though databases did not seem to load very quickly.

Maximizer 3.0is adds significant new functionality that will prove especially useful for SOHO users without sacrificing any flexibility—all at a competitive price.

MultiActive Maximizer 3.0is for Windows 95. Estimated street price: $149. Requires: 8MB RAM, 10MB hard disk space, Microsoft Windows 3.*x*, Windows 95, Windows NT. Maximizer Technologies, Vancouver, British Columbia, Canada; 800-804-6299, 604-736-9666; http://www.maximizer.com. *Circle 403 on reader service card.*



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DELL

MICROSOFT WINDOWS NT READY-TO-RUN

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Dell's featured computer artist is Marco Marinucci of San Francisco, CA.

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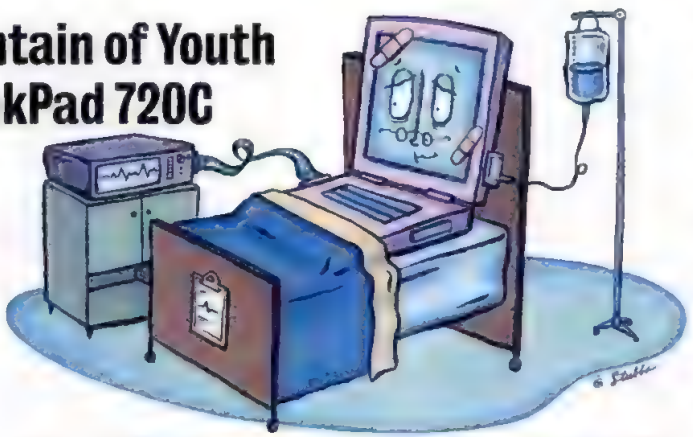
Second Looks

LIVING WITH THE PRODUCTS WE REVIEW

By Brian Nadel

NOTEBOOKS

Finding the Fountain of Youth For the IBM ThinkPad 720C



WHEN CONTRIBUTING EDitor Sheryl Canter reviewed the IBM ThinkPad 720C (August 1993), she liked the Editors' Choice–winning notebook so much that she bought one. Though the ThinkPad 720C was state of the art in the summer of 1993, today it needs revamping to handle the rigors of Windows 95—a process not helped by IBM's failure to provide the needed hardware, software, and support.

By upgrading or replacing most of its major software and hardware components with parts supplied by third parties, Sheryl gave her 720C a new lease on life. But it was neither cheap nor easy.

The most glaring deficiency was data storage; the 720C's 160MB disk drive seems minuscule today. Sheryl chose an $898 Corporate Upgrades (800-240-6190) 520MB drive, which required a BIOS upgrade. Higher-capacity drives from Sigma Data (800-446-4525) don't need a BIOS upgrade but lack 32-bit drivers.

The hardest part was getting to the ThinkPad 720C's BIOS chip, which is buried beneath the video board. After taking the notebook half apart, Sheryl delicately removed the old chip and inserted the new one. If this is more than you bargained for or your screwdriver skills are rusty, Corporate Upgrades will do the work for you and charge you for shipping.

With the 720C's new drive in place, the next step was to replace its 50-MHz 486SLC/2 processor with a 75-MHz Blue Lightning CPU, available for $498 from Corporate Upgrades. The 720C's CPU is on a daughterboard that is easily accessible with the bottom of the case removed.

The PCMCIA software supplied by IBM for the 720C doesn't comply with current standards, so the next step was to install the $69.95 CardWizard Pro for Windows 3.1 from SystemSoft (800-449-7973). This version doesn't provide 32-bit drivers and is one version behind the current PC Card standard, so it won't handle multifunction cards.

The last and most problematic upgrade involved graphics. Although IBM has a 16-bit, 256-color driver for Windows 3.1, there's no 32-bit Windows 95 driver. You must install this driver manually, because IBM's installation program puts the Windows 3.1 fonts on your system, which will cause it to freeze frequently. The 256-color driver usually works but is incompatible with some programs.

More than just a face-lift, the $1,500 process opened the 720C to the world of Windows 95 and improved performance in some areas. The biggest gain was seen on our Disk WinMark 96 benchmark tests; the score increased over 50 percent, from 183 to 290. The CPUmark processor test scores increased only marginally. On the whole, the rejuvenated 720C had a Winstone 96 score of 11, which is about one-third the performance of a Pentium/75 notebook.

Unlike Ponce de Leon, Sheryl found her fountain of youth, although its cost was so close to that of a brand-new Pentium-powered notebook that others may not be willing to pay the price.

PAGE SCANNERS

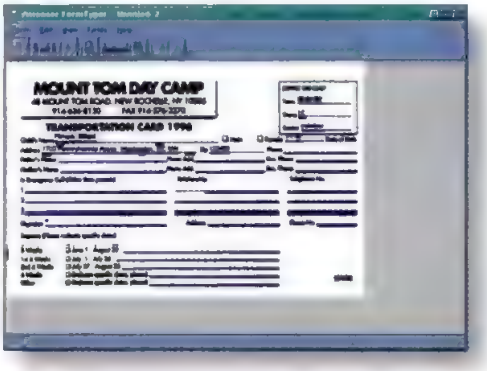
PaperPort Vx's Form Filler

IN OUR INITIAL REVIEW OF Visioneer's page scanner, PaperPort Vx, we were delighted with the built-in links to more than 100 popular document-centric applications (First Looks, January 9, 1996). Unfortunately, the PaperPort lacked an easy way to fill out scanned forms. Its annotation tool required the user to place text boxes on forms visually to insert text.

The company's FormTyper changes all that by converting a form's fill-in blanks into data-ready fields. Once the scanned form is on the PaperPort Desktop, just drag its thumbnail image over the FormTyper icon and the image appears on-screen with blue lines, which clearly identify the slots into which you need to insert text.

During our evaluation, FormTyper correctly placed fields on a variety of forms. All we had to do was tab among them and type in the information. The only trouble spot was check boxes, which the program often ignored; you can use the annotation tool as a fallback here.

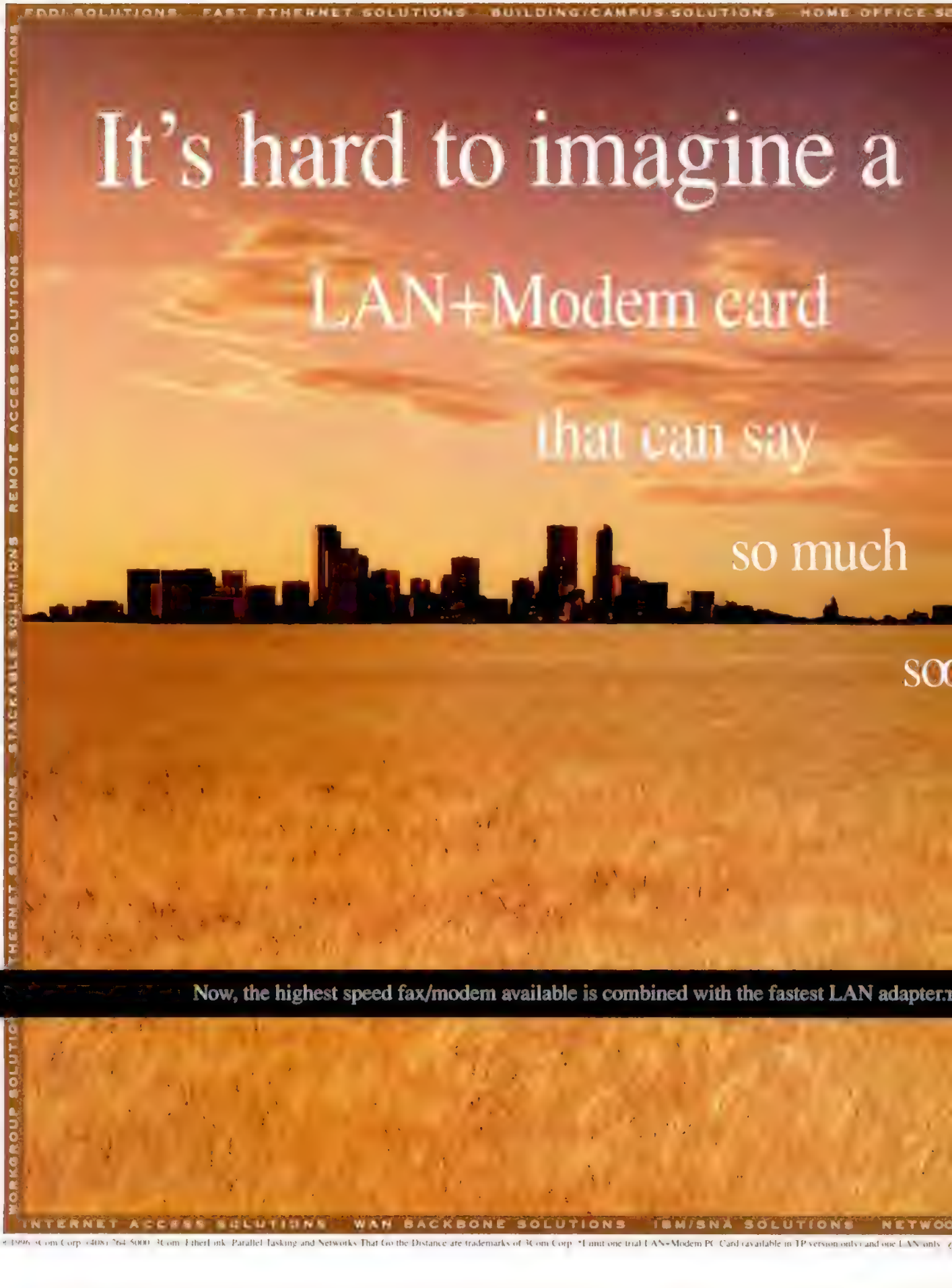
FormTyper costs $19.95 and is available from Visioneer (800-787-7007).



LOOKING AHEAD

Tell us what you love and hate about these products and we'll share the information in future issues. • ClarisWorks 4.0 • Color ink jet printers • CD-ROM encyclopedias • EZ-SCSI 4.0 • Lotus Notes Release 4 • Microsoft Internet Explorer • Netscape Navigator 2.0 • Pentium Pro PCs • RealAudio • Windows 95 utilities. Contact Brian Nadel directly via MCI Mail (556-1500) or CompuServe (72241,1616), or on the Internet at *bnadel@zd.com*.

ILLUSTRATION BY CHARLES STUBBS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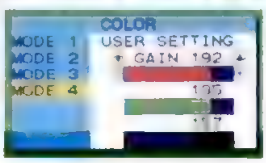

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CIRCLE 329 ON READER SERVICE CARD

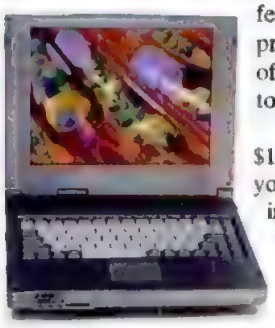
New & Improved

NEWS OF ANNOUNCED PRODUCTS AND UPGRADES

By Melissa J. Perenson

Portfolio or Notebook PC?

THAT'S THE QUESTION YOU'LL BE ASKING YOURSELF ONCE you've seen the **Twinhead Slimnote 700 Series** of notebook computers. Similar in size and concept to the IBM ThinkPad 560 Series, which we featured as a Hot Prospect (New & Improved, June 25, 1996), the Slimnote Series offers the first lightweight subnotebook PCs to integrate a floppy disk drive.



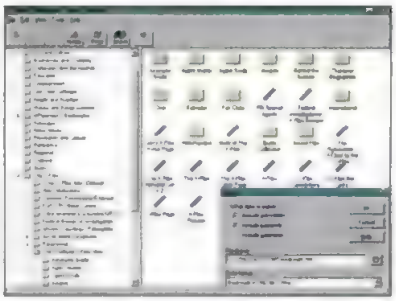
The Slimnote 700 units, which start at $1,995, have a profile that resembles that of your average portfolio—9.3 by 11.7 by 1.4 inches—and weigh only 4.5 pounds. Available with 75-, 100-, or 120-MHz Pentium processors and 11.3- or 12.1-inch active-matrix displays, the systems each come standard with 8MB of RAM, a 1.3GB removable hard disk, 1MB of RAM on the PCI local-bus VGA controller, an IrDA port, a nickel hydride or optional lithium ion battery, and a Type III PC Card slot. The systems feature comfortably sized keyboards and Synaptics touch pads.

An optional $569 docking base station, which fits beneath the notebook, includes a CD-ROM drive, speakers, and a PCI slot.

Twinhead Corp., Milpitas, CA; 800-995-8946, 408-945-0808; fax, 408-945-1080; http://www.twinhead.com. *Circle 412 on reader service card.*

The Smarter Marks

WITHOUT BOOKMARKS, THE World Wide Web is like a vast, uncharted region with no geographic markers to help you find your way. That's why First Floor Software's $24.95 **Smart Bookmarks 2.0** is so much like having your own automatic-pilot guidance system.



Enhancements make this version a terrific way to both organize your bookmarks and monitor updates to your bookmarks off-line. Using intelligent-agent technology, Smart Bookmarks lets you assign monitoring properties to groups of bookmarks or to individual URLs. At the appointed time, the monitor will go out and either report back as to whether a page has been modified or retrieve the entire page, including all images and hypertext links, and store it on your hard disk. There's also a handy Web Search feature for using Internet search engines through a common interface.

Smart Bookmarks works with numerous browsers and integrates itself with Netscape Navigator, Microsoft Internet Explorer, and Spyglass Enhanced Mosaic.

First Floor Software Inc., Mountain View, CA; 800-639-6387, 415-968-1101; http://www.firstfloor.com. *Circle 410 on reader service card.*

A Wave of MIDI Sounds

FOR REMARKABLE SOUND, try Yamaha Corp. of America's wavetable-sound upgrade card, the $299.95 **WaveForce SW60XG.** The ISA-bus card works as a standalone or with your Sound Blaster–compatible card or motherboard-based sound card. The WaveForce employs Yamaha's new XG MIDI format, which carefully controls the subtle nuances of sound; the resulting audio sounds incomparably real. The WaveForce offers 686 wavetable voices, 21 drum kits, 32-note polyphony, and 4MB of ROM.

PHOTOGRAPHS BY THOM O'CONNOR

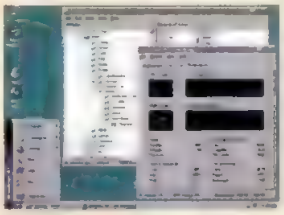
Yamaha Corp. of America, 800-823-6414, ext. 199, 714-522-9011; http://www.yamaha.com. *Circle 413 on reader service card.*

HOT PROSPECT

A Friendlier Windows NT

It looks like Windows 95, feels like Windows 95, and even smells like Windows 95. But don't be fooled: Underneath the glossy new interface, **Microsoft Windows NT Workstation 4.0** and **Server 4.0** (shown below in beta; pricing to be determined) is an improved version of the same reliable, durable Windows NT operating system you've grown to love.

Windows NT's cosmetic face-lift is perhaps the most obvious—and drastic—change from Windows NT 3.5, but there are plenty of other additions to the operating system that strengthen Windows NT's network integration and Internet access.



New to Windows NT 4.0 are Microsoft Internet Explorer 2.0; client-side support of the Point to Point Tunneling Protocol (PPTP) for connecting to secure, private intranets and sending encrypted data; Peer Web Services, for easily creating personal Web pages and documents for posting on corporate intranets; client-side support for NetWare Directory Services (NDS); and a MAPI 1.0-compliant universal in-box client. You can achieve higher data-access and -transfer speeds, as the dial-up networking now offers channel aggregation for combining all available dial-up lines; this is a particular boon for ISDN users. The only weakness of this OS is the lack of support for mobile computing.

Microsoft Corp., Redmond, WA; 800-426-9400; fax, 206-726-9341; http://www.microsoft.com. *Circle 429 on reader service card.*

Adding to PageMaker

IF YOU'RE A REGULAR USER of Adobe PageMaker 6.0, Extensis Corp.'s $99 **PageTools for Windows** is a worthwhile investment. It offers five plug-ins that add to PageMaker: PageType, for creating and applying character-based styles; PageMarks, for drawing crop or registration marks at specified locations; PageCaps, for quickly changing the case of selected text; and PageCounter, for counting the characters, lines, paragraphs, and words of selected text.

Extensis Corp., Portland, OR; 800-796-9798, 503-274-2020; http://www.extensis.com. *Circle 411 on reader service card.*

Canon's Point-and-Shoot

DRAWING ON ITS EXPERIENCE IN BOTH PHOTOGRAPHY AND computing, Canon Computer Systems has come up with its first point-and-shoot digital camera. The $950 **PowerShot 600** features an auto-focus lens with a focal length of 7.5 millimeters (mm) at f/2.5 (the equivalent of a 50-mm lens in the common 35-mm camera standard) and shutter speeds of 1/30 second to 1/500 second. You can capture JPEG images in 24-bit color or 8-bit high-resolution monochrome; up to 18 images can be stored internally, and up to 72 images can be stored on a PC Card. The 14-ounce camera comes with a Twain driver and a docking station for connecting the camera to a high-speed parallel port.

Canon Computer Systems Inc., Costa Mesa, CA; 800-848-4123, 714-438-3000; fax, 714-438-3099. *Circle 414 on reader service card.*

Perfect Suite

IN KEEPING WITH WORDPerfect's cross-platform tradition, Corel Corp. has released **Corel WordPerfect Suite for Windows 3.1** concurrently with the new and enhanced 32-bit suite (see First Looks review in this issue).

Priced at $395 ($129 for a competitive upgrade), the suite bundles multilingual modules of the Windows 3.1 versions of WordPerfect, Quattro Pro, Envoy, and Presentations with AT&T WorldNet Service, CorelFlow 2, Starfish Software's Dashboard 3.0 and Sidekick 2.0, and a collection of fonts and clip-art images.

Corel Corp., Ottawa, Ontario, Canada; 800-772-6735, 613-728-0826; http://www.corel.com. *Circle 409 on reader service card.*

In Living 3-D

LOOKING FOR ready-to-render 3-D models to enliven your 3-D applications and documents? Then take a look at the catalog of offerings from **Acuris.** The eight catalogs range in price from $49 to $499 and encompass general graphics and textures; air, sea, and land transportation; home furnishings and landscapes; and male and female human models.

Acuris Inc., Washington Crossing, PA; 800-652-2874; fax, 215-493-4305; http://www.acuris.com. *Circle 425 on reader service card.*

Modems with Attitude

IF YOU'RE LOOKING FOR A MODEM WITH ITS own voice, consider these offerings.

U.S. Robotics' $230 **Sportster Voice 28.8 Faxmodem** turns modem communications on its side. Literally. One of the rare external modems that may be used either vertically or horizontally, this sleek device pushes the limits by supporting speeds of up to 33.6 Kbps. You can use the modem, which supports Caller ID, as your multiple-mailbox answering machine or full-duplex speakerphone. The modem also detects an incoming fax call and automatically switches functions to accept the fax.

For Digital Simultaneous Voice and Data (DSVD) telecommunications, there's Archtek America Corp.'s **SmartLink Mwave DocuPal V.34 Multimedia DSVD Fax/Modem.** The $439 modem will automatically regulate the data transmission stream so that you're working at 28.8 Kbps for data only and 14.4 Kbps when voice is added to the data stream. The modem also features telephony and MIDI functionality.

U.S. Robotics, Skokie, IL; 800-342-5877; fax, 847-676-7320; http://www.usr.com. *Circle 417 on reader service card.*

Archtek America Corp., City of Industry, CA; 888-912-8880, 818-912-9800; fax, 818-912-9700. *Circle 418 on reader service card.*

Bulletin Board With a Twist

IF YOU DON'T WANT TO deal with Web servers but want to create an HTML-based online service to call your own, try Mustang Software's **Wildcat 5 for Windows 95/NT.** Priced at $699 for 32 concurrent users, Wildcat 5 updates Mustang's BBS software to an HTML system.

Wildcat 5 combines the best of both worlds, offering the viewing flexibility of the Web and the internal security, messaging, file management, and teleconferencing capabilities of a BBS. Although Wildcat does not make a true PPP connection, the software can be used as a proxy server for access to the Web. Alternatively, Web and FTP access to other sites can be disabled.

Mustang Software Inc., Bakersfield, CA; 800-999-9619, 805-873-2500; http://www.mustang.com. *Circle 421 on reader service card.*

BRIEFS

Books

If you want to get more out of Windows 95, ***Success with Windows 95***, by Kris Jamsa and Naba Barkakati, will show you how. Written for users at all levels, ***Success with Windows 95*** covers everything from creating shortcuts to configuring TCP/IP settings ($29.95, Jamsa Press, 800-432-4112) .... ***HTML 3 How-To***, by David Kerven, Jeff Foust, and John Zakour, is a troubleshooting guide for Web-page builders. It provides solutions to 150 common programming problems and includes a CD-ROM with software, sample code, and a collection of interesting Web pages ($39.99, Waite Group Press, 800-428-5331) .... If you want to get your kids on the Internet but aren't sure where to begin, Nyla Ahmad's ***CyberSurfer*** is the perfect solution. A colorful, concise guide to computers and the Web, ***CyberSurfer*** includes a floppy disk with links to 300 sites for children ($19.95, OWL Books, 416-971-5257).

Software

Windows NT users will flock to Symantec Corp.'s $49.95 **Norton NT Tools**, which provides such essential functionality as antivirus protection, file management, and viewing and monitoring of key system information (800-441-7234) .... Unlike your average multimedia authoring tool, Innovus Corp.'s **Innovus Multimedia 2.1** (priced at $1,195 for up to 50 users) is designed for business users. Modeled after presentation software, Innovus features a powerful set of authoring tools, easy deployment over a LAN, and support for FTP, multiple databases, ODBC, Visual Basic for Applications, and the Web (801-463-8200) .... On a more lighthearted note, Midisoft has two

No other digital camera puts as much focus on the output.

Epson PhotoPC Digital Camera

"It blew the socks off everyone I showed it to." —Jason Shane, Technical Consultant, Coldwell Banker

"Epson's PhotoPC is just as impressive as it is inexpensive." —PC Magazine

"The PhotoPC's quality is outstanding, even compared to digital cameras costing twice as much." —Jon Pepper, Family PC

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  - Preview pictures taken
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For more details, call 1-800-GO-EPSON. Ask for operator 3050. Or to experience PhotoPC image quality, visit our Web site (http://www.epson.com). Download a few brilliant images from our Digital Photo Gallery, and see the difference for yourself.

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In Canada, call 1 800 387 3867. Average U.S. street price. Monitor not included. Other capacities available. HP Vectra PCs come with MS-DOS® 6.2 and MS Windows for Workgroups 3.11 or Windows 95. OS/2 or Windows NT included. First year on-site, 24 hour next day service. Second and third year, return to dealer. Microsoft, MS-DOS, Windows and Windows NT are U.S. registered trademarks of Microsoft Corporation. Pentium and the Intel Inside logo are U.S. registered trademarks of Intel Corporation. OS/2 is a registered trademark of the International Business Machines Corporation.

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- PCI Matrox Millenium graphics card with 3D acceleration and 2MB WRAM, upgradable to 4MB or 8MB
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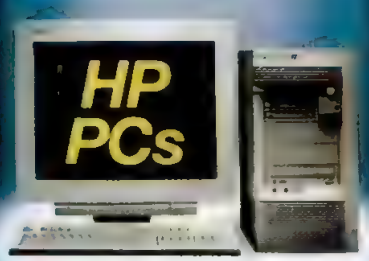

HP Vectra VT

Helpful hint:

Rip out and pin up next to Compaq and IBM ads.

A little comparison shopping will quickly show you that HP puts the best prices on the most impressive PCs. One standout is the network-ready Vectra XM. It's configured for the most demanding networks with LAN Remote Power, Super-fast LAN install and HP Vectra Op-Center for more effective remote management. Every Vectra will outshine the competition when it comes to features and price. From the Pentium® processor-based PCs to the dual Pentium Pro processor-based HP Vectra XU PC. For more information or the name of your nearest HP reseller, call 1-800-322-HPPC, Ext. 1703! Or visit us at http://www.hp.com/go/vectra.

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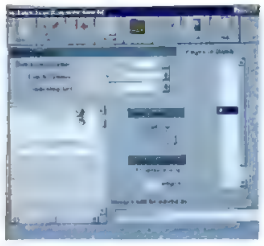
Storage Chest

AT THE ENTERPRISE-WORKflow high end of document management solutions, there's Highland Technologies' **HighView Standard Version 1.0,** a $1,500 product (or $2,400 for six users) that provides a variety of file organization tools, including batch scanning, custom indexing, form creation, keyword searching, document routing, document annotation, and support for e-mail, faxing, and printing.



Executive Technologies' **SearchExpress Document Imaging,** which costs $2,995 per server plus $99 per user, offers another powerful means for organizing your documents. The software has several options, so you can retrieve your documents ranked in order of relevancy or conduct searches using agents or Boolean parameters. The Twain-compatible package supports Acrobat and HTML documents.

On the personal-desktop side, there's MindWorks Corp.'s $149 **Recollect.** Recollect lets you import, manage, scan, and search your documents. There's integration with Visioneer's PaperPort scanner and software and Symantec Corp.'s faxing software, WinFax PRO.

Highland Technologies Inc., Lanham, MD; 800-306-8266, 301-306-8200; fax, 301-306-8201. *Circle 422 on reader service card.*

Executive Technologies Inc., Birmingham, AL; 205-933-5494; http://www.cris.com/~eti/. *Circle 423 on reader service card.*

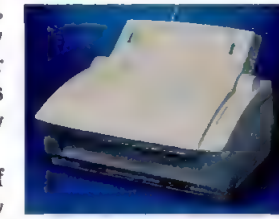
MindWorks Corp., Sunnyvale, CA; 800-683-8005, 408-730-2100; fax, 408-730-5202. *Circle 424 on reader service card.*

Sleek and Colorful

VIEWSONIC CORP.'S LATEST 17-INCH monitor is the $945 **ViewSonic PT770.** The PT770 has a 16-inch viewable display, a 0.25-mm aperture-grill mask pitch, resolutions of up to 1,600-by-1,280, and a 77-Hz refresh rate at 1,280-by-1,024. The monitor, ideal for graphics-intensive users, has a vertically flat display.

ViewSonic Corp., Walnut, CA; 800-888-8583, 909-869-7976; fax, 909-468-3756. *Circle 416 on reader service card.*

A New Breed of Personal Lasers



BROTHER INTERNATIONAL CORP., which has repeatedly broken ground by offering low-cost, high-quality laser printers for the SOHO market, has raised the bar once again with its new line of **HL-700** printers.

The units in the HL-700 series of laser printers feature a sleeker, new design with 600- by 600-dot-per-inch resolution, a 6-page-per-minute engine, and such flexible printing abilities as a straight paper path and support for specialized printing needs, including printing on oversize 9- by 12-inch envelopes.

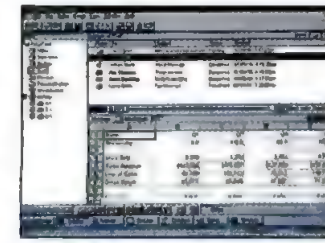
The entry-level HL-720, with 512K of memory, is aimed at the Windows market and will cost just $350.

Brother International Corp., Somerset, NJ; 800-284-4357, 908-356-8880, ext. 4513; fax, 908-764-4482. *Circle 420 on reader service card.*

A Complete Communicator

TAKING THE UNIVERSAL IN-box approach to communications is Global Village Communication's FocalPoint.

This $129 package integrates data, e-mail, fax, Internet, paging functionality, speakerphone, and voice mail under a single roof—and interface. Regardless of the format, managing your incoming messages is a breeze, thanks to a universal in-box that collects and displays messages in one place; sending messages is equally simple, thanks to a single address book for your e-mail, faxing, paging, and telephoning needs. A handy feature lets you set FocalPoint to go online automatically and retrieve your e-mail from America Online, CompuServe, and the Internet.



Global Village Communication Inc., Sunnyvale, CA; 800-329-9675, 408-523-1000; http://www.globalvillage.com. *Circle 419 on reader service card.*

BRIEFS

new music software products available. The $79.95 **Midisoft Play Piano** is a CD-ROM that teaches you to play your favorite songs without formal piano lessons. The $199.95 **Midisoft Studio 4.0** allows you to arrange, compose, edit, and record music (206-391-3610).

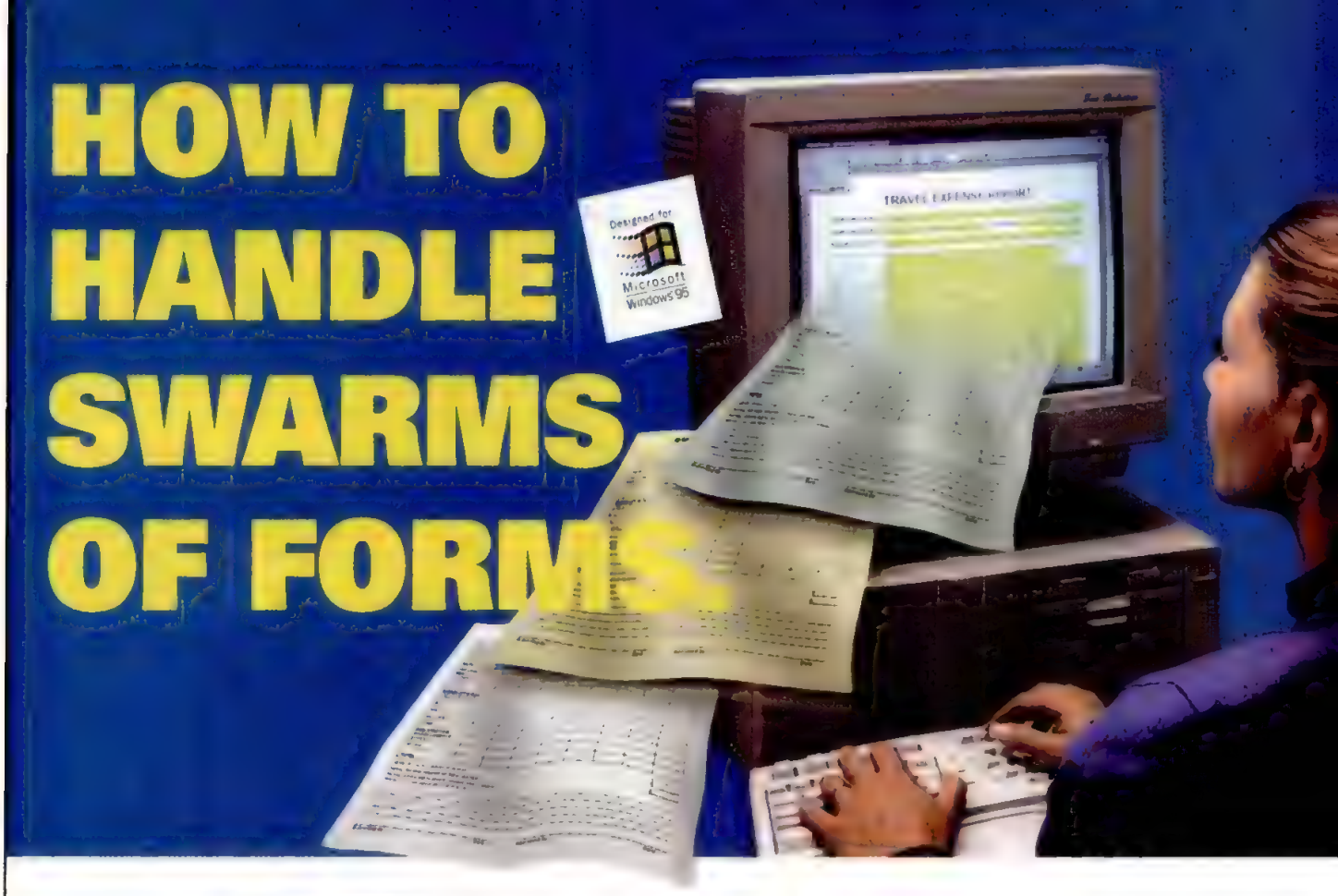
Internet

Progressive Networks has finally released **Real Audio System 2.0** (player, free; software, $29.95) from beta testing. The 32-bit software, which allows you to play audio streams on the Internet using the RealAudio format in real time, has improved the sound quality and added synchronized multimedia for presentations with audio and integration with Netscape Navigator (*http://www.realaudio.com*) .... Creating a Web page? Ocean State Publishing Corp.'s **Web Whiz** is a complete $24.95 solution to help you get started (800-959-7477).

Hardware

For serious thermal dye transfer color printing, there's the **Kodak Digital Science 8650,** a $9,995 color printer. A PostScript-compatible, or *raster* printer, that outputs in three colors or black, it can print on 9.5- by 14-inch media and comes with 32MB of memory (800-235-6325) .... **PerfecTouch's** $89 101-key ergonomic keyboard splits into two adjustable sections for more ergonomic, comfortable angling (800-859-2225) .... Has your old notebook PC's original battery limped through its last recharge? Or do you need a second battery for your newest laptop? **Power Express,** a notebook-accessories supplier specializing in batteries, has the right battery for you (408-879-1930).

HOW TO HANDLE SWARMS OF FORMS.



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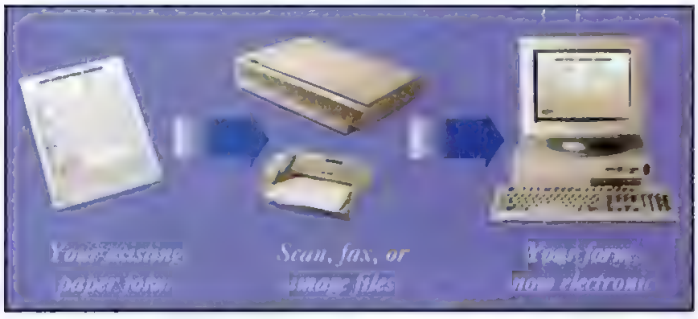

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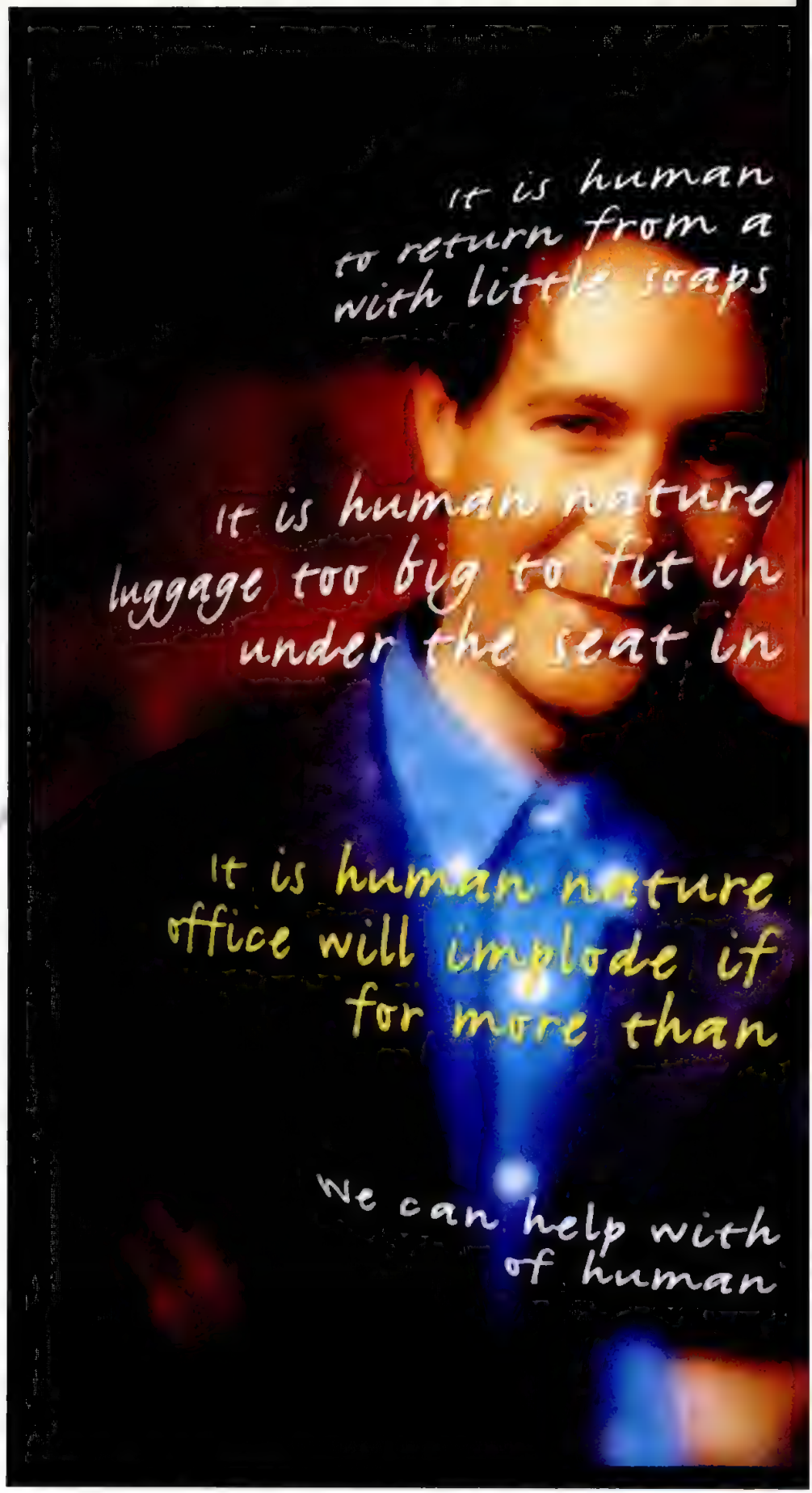

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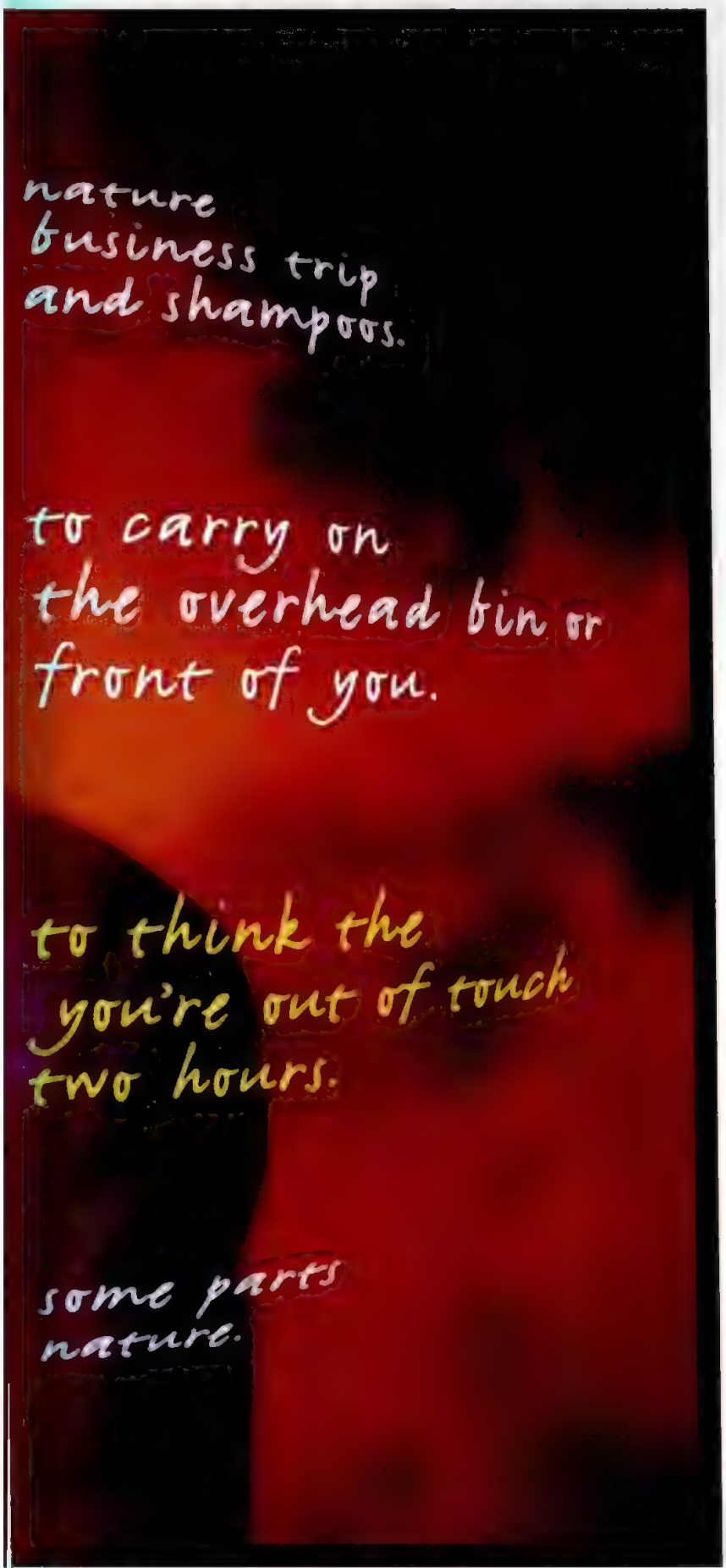

It is human nature to want to communicate at any time, from anywhere. And in this respect, the business traveler is just a bit more human than most.

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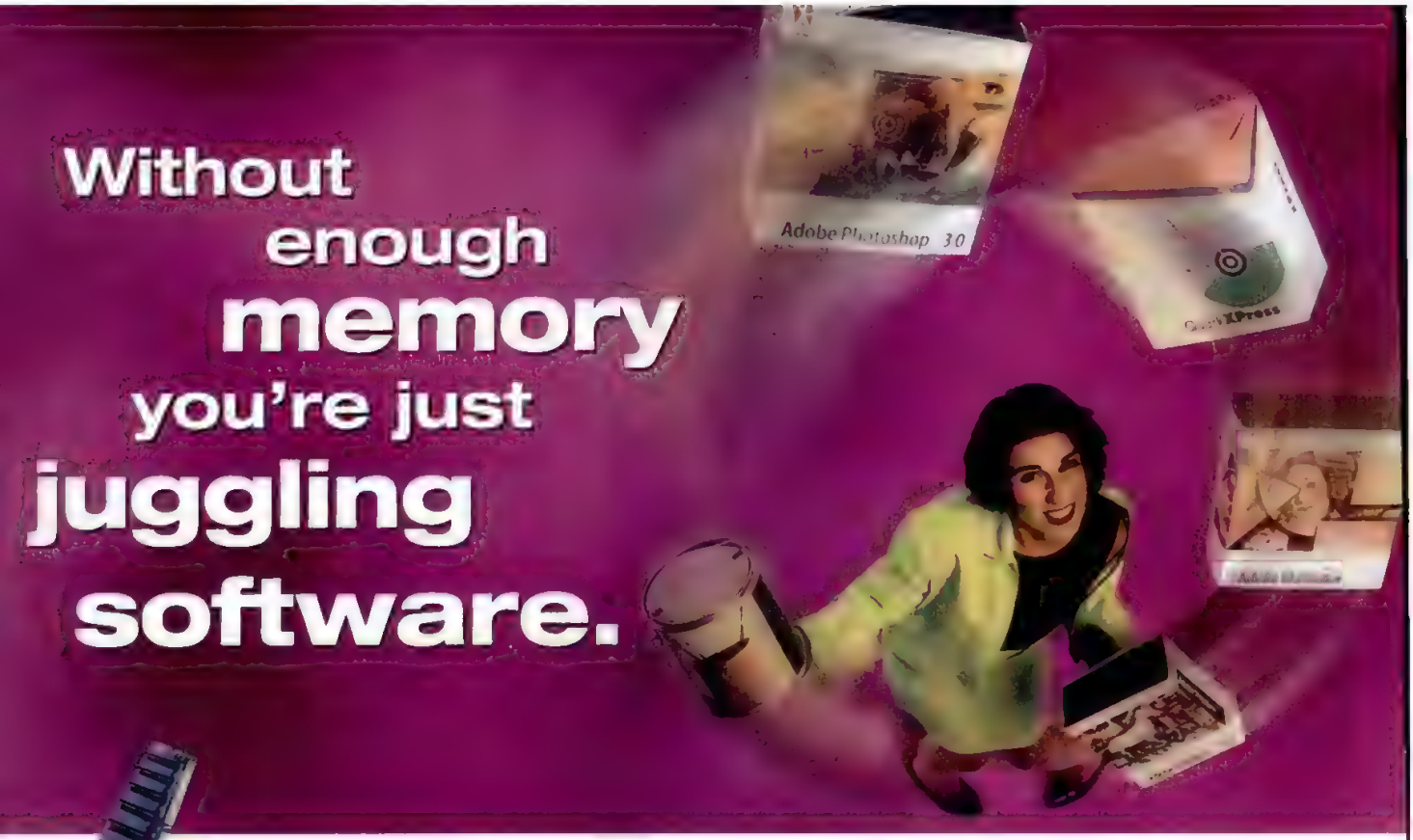
Without enough memory you're just juggling software.



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BILL MACHRONE

Will the Internet Crash?

A spike in traffic on a busy Internet service provider's system causes a hitherto-undetected bug to surface in a router that hands off packets to one of the system's backbones. The bug crashes the router. Millions of data packets bounce off the router, and given the self-healing properties of the Internet's design, another router attempts to pick up the traffic. Unfortunately, it's the same make and model as the one that failed under load, and it dies the same horrible death.

In a nightmare scenario worthy of a Tom Clancy novel, the dominoes continue to fall until the magnificent, well-oiled machine that was the Internet is reduced to a quivering mass of local nodes carrying sporadic traffic, while a virtual silence echoes across the once-mighty backbones. Millions of users pound their fists in frustration and shout imprecations at their screens. Such calamities are not unknown. A bad circuit breaker (or, say some extremists, a UFO) caused a chain reaction that blacked out most of the Northeast back in the mid-1960s.

Could it happen? Sure. It's what pessimists live for. Will it happen? Not likely. I'd be the last person to tell you that any system is foolproof or that all of the bugs have been caught, but telecommunications systems are well monitored and continually spew out exhaustive statistics and logs. ISPs ignore them at their own peril, as do Web administrators. The companies that carry the Net's all-important backbone traffic are long-distance telephone companies, and they know a thing or two about queuing, statistics, and unruly clients.

Back in 1984, long before ZD Net, there was PC MagNet, a service begun so our readers could download the utilities we published in the magazine. PC MagNet started as a PC XT running two modems, but reader demand kept it growing until we were running 48 lines in New York and 36 lines in San Francisco. We weren't on a network—access was free, but you paid the long-distance charges.

One day, I got a call from the folks at AT&T's long-distance operations center. They wanted to know if I was in charge of PC MagNet. I said yes, whereupon they said that we had to shut it down, and if we didn't, they would. I wouldn't call our exchange the height of customer-friendly conversations, but the bottom line was that we were causing major problems on the long-distance network. It seems that each time our magazine arrived at their homes, tens of thousands of readers all called (or tried to call) one of our two numbers. The resulting busy signals caused statistical aberrations unlike any the long-distance folks had ever seen. In fact, the call peaks were so well orchestrated, AT&T thought we were pulling some kind of prank or purposely trying to crash an area code or two. (How's that for paranoia?)

IN THE INFO-DARK

Calamities are not unknown, but it's unlikely the Net will suffer a catastrophic collapse.

We moved quickly to CompuServe to get off the public switched network. We're still there, but the real action today is at our Web sites, *http://www.pcmag.com* and *http://www.zdnet.com*.

The point is simple: If high volume were to threaten the integrity of the network, the people in charge of keeping it running would think nothing of pulling a high-volume, nonessential site or two off-line to keep the data flowing in more essential areas, such as e-mail. My guess is that a bunch of leering guys could go without their megapixel downloads from *playboy.com* if it meant the difference between a functioning Web and the doomsday scenario.

Despite the frequent characterizations of the Internet as a place where no one is in charge, real people in real companies are the service providers, run the network access points (NAPs), and supervise the metropolitan area exchanges (MAEs). They may not have any idea of how many packets per second are going to beleaguer their routers and fiber connections, but these supervisors know exactly what they'll do if a router fails or if a hunk of fiber drops off-line.

These people aren't working for free. They get a piece of your connect charges, and you can bet that they're making money on the deal. Some pundits worry about the effect of massive streaming audio and video on the Internet. It hasn't arrived yet, but when it does, we'll pay every step of the way for the necessary increases in bandwidth and router performance. The long-distance companies have unused bandwidth in the form of dark fibers that are just waiting for the right application to bring them online.

In the meantime, problems? Sure. Slowdowns? Yes. A catastrophic crash that leaves us in the info-dark? No way. □

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CIRCLE 203 ON READER SERVICE CARD

JOHN C. DVORAK

Living Under a Microscope

As I write this column, the largest known kiddie-porn ring in U.S. history has just been busted by Federal agents. News reports are depicting how the sting went down: Postal Service authorities raided the house of a suspected child pornographer and, after discovering a mailing list, set out to solicit buyers. Undercover postal inspectors, posing as letter carriers delivering the tapes, busted the guys who wanted this stuff. Everything was done through the mail. You could hear upstanding citizens applauding in the background. Bad guys in jail. End of story. Great bust, right?

Curiously, after the arrests, nobody suggested the Postal Service should be abolished because pornographers use it to send indecent material. Think of the slogans: "If there were no Post Office, there would be no porn." Not once was the mechanism for delivery—the postal system—ever brought up in any critical way.

But just imagine the outcry if the Internet or a commercial service such as America Online or CompuServe had been involved. There would be a movement for legislation to prevent the use of technology for such activities. We'd see story after story about how out-of-control the Internet and online services have become. People would be calling for a ban on modems. Heck, just take look at the Telecommunications Bill and the Communications Decency Act rider, which impose much stricter regulations for online activities than for print media.

Fact is, the technological progress we make as a society is overscrutinized. Years ago, I was chatting with former *Nightline* correspondent Jed Duval about technology when he observed that the news media always overemphasizes any connection between new technology and any sort of negative outcome, oddity, or disaster. People are killed by the thousands slipping in their bathrooms, for example, but it's seldom reported. Meanwhile, some loner in Nebraska crashes his Cessna into a farmhouse and it's national news. Apparently, the loss of life isn't as important as the technology involved. And the newer the technology, the greater the scrutiny.

Lately, I've spent some time thinking about why that is. During the early days of the Industrial Revolution, steam boilers would blow up and make front-page news until licensing and inspection systems were in place to prevent such accidents. Now, you never hear about a boiler exploding. Odd as it sounds, the excessive scrutiny actually worked to make boiler systems safer.

Likewise, you've got to give the media credit for ranting about safety features like airbags until they became standard equipment in most cars. I have a friend whose life may have been saved by an airbag. Similarly, one guy in a Piper Cub crashing into a silo in Kansas should not be national news, but when it is overplayed, the likelihood of another wreck is lessened.

HUMAN ERROR

We can't trust technology. It can have all sorts of unknown flaws, especially in its infancy.

So it goes with more recent technology. Subconsciously, people worry about it. This seems silly to a technologist, but not to the general public. The fact is, we can't trust a product of technology. It's a piece of machinery, and it can have all sorts of unknown flaws—especially in its infancy. It could even blow up. After all, technology comes from the minds of humans and we simply can't expect to achieve perfection in our creations.

The personal computer, which has been a target of scrutiny since its inception in the 1970s, is under renewed attack with the rapid expansion of the Internet. The criticisms change over time. First, the PC was a homewrecker (circa 1978). The term "computer widow" was in vogue. Then it became some sort of hero and *Time* magazine proclaimed the device "Man of the Year" in the early 1980s. With the IBM PC revolution, a debate ensued over whether the computer actually increased productivity. Since nobody could prove that it did, the answer was a resounding (and wrongheaded) "No." Then along came business downsizing. People began mumbling about how PCs were actually displacing jobs, while making those who still had jobs much more productive. Now the computer is a connectivity tool that will change the world yet again. The Internet era has arrived, and with it, the scrutiny has intensified.

Sometimes, I think these shifts in public opinion are pretty ridiculous. But when I view them in an historical context, I realize how important scrutiny can be. There's nothing wrong with careful examination of change—after all, that's what technology is about: change.

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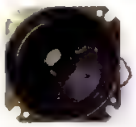

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MONITORS

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JOHN C. DVORAK

Inside Track

So what's the story with **Cyrix's entry into the computer market?** Look for loads of publicity surrounding its machines, because Cyrix has seeded the media with these things like no other company before them. I, too, have a loaner system. Someone obviously took the hint from Apple. The machine is **very fast indeed,** and Cyrix has done a credible job of moving from chip maker to computer maker. My in-house game fanatic (my ten-year-old son) tells me that every CD-ROM game in the house works on this thing. Surely a **true torture test.**

Cyrix has always come up with gimmicks to compete with Intel. The latest trick is the **P-rating,** whereby Cyrix's 133-MHz 6x86 chip is called a P166+, because it has the **same performance as a Pentium/166.** Intel is now shipping a 200-MHz Pentium, which Cyrix plans to match in performance. One interesting note: While the Pentium/200 is constrained to a 66-MHz system bus, Cyrix will be pushing for a 75-MHz bus later this year.

Cyrix says it will ship an MMX-compatible chip in the first quarter of 1997. Code-named the M2, the chip will drop right into the socket of today's Cyrix P166+ systems and automatically upgrade the computer to M2/MMX.

In addition, to counter Intel's P55C processor with MMX instruction set, due by year's end, Cyrix says it will ship an MMX-compatible chip in the first quarter of 1997. **Code-named the M2,** the chip will drop right into the socket of today's P166+ systems and automatically upgrade the computer to M2/MMX, according to Cyrix. Finally, Cyrix has been showing some **odd technology called GX** that is apparently similar to NSP and will be used to promote signal processing as a substitute for the more expensive circuitry in laptops.

Meanwhile, odd-man-out **AMD is still struggling** with its K5 CPU. Expect to see it shelved for the K6, based on the Nx686 from NexGen, which should have **Pentium pinouts** but deliver Pentium Pro performance. Most observers say it will take AMD about six months to catch up to the performance leaders.

Who Is to Blame Dept.: Recently, at one of the many Internet-related events, I discovered an interesting phenomenon. Speaker after speaker complained bitterly about how the media is sensationalizing the issue of **security on the Internet.** After all, they noted, people gladly hand over their credit cards to the creepy, goateed clerk at the convenience store or give the card numbers to a mail-order operator. Talk about lack of security. In the Pacific Northwest, news reporters have been Dumpster diving outside local banks, retrieving all sorts of confidential information that could be used to defraud people. Maybe that's blown out of proportion, too.

The fact is, **the industry itself is preoccupied with security.** Company after company harps on it. The most recent Chicken Little scrambling has been initiated by a series of ads from IBM promoting its Secure Electronic Transactions protocol. Gosh, and we thought the *media* was blowing this out of proportion. Anyway, you **security freaks** can find out more about it at *http://www.ibm.com/security*.

While you're at the IBM site, check out **John Patrick's vanity page.** Patrick, the personable IBM Internet vice president, created the entire page using Internotes, a cool product available with Lotus Notes. Using a Notes database, the program makes a Web site that can be easily and **automatically updated.** Seems rather useful.

Thoughts on Digital Cameras Dept.: My evaluation of the various digital cameras on the market continues. Currently, I recommend the **Kodak DC-50** for its overall image quality and ease of use. By this time next year, however, there will probably be a dozen better cameras. Already, we're beginning to see some price erosion and product enhancement. Right now, you can expect to pay about $1,000 for one of these filmless cameras, but I can envision them selling for under $200. Heck, I can easily imagine a $49 camera. And there are no moving parts.

For a sample of digital photography, visit my Web page at *PC Magazine*'s site (*http://www.pcmag.com*). A basic image taken with a low-end digital camera is a bitmap file of about 1MB in size. Although this format doesn't provide the kind of image detail you need for magazine reproduction, it works fine for online uses and would even be sufficient for many newspapers. You can easily stuff 30 pictures in JPEG format on a single floppy. But the temptation is to keep the larger files even though, at a megabyte each, they can quickly clog up your hard disk.

I have been looking at the various storage technologies for addressing this problem. I especially like the small optical drives, specifically the 230MB optical units. Look for the $399 **Olympus Deltis 230MO optical drive** at trade shows. It's one of the fastest units available. Olympus, a well-known camera manufacturer, is rumored to be working on a **killer, low-end digital camera.**

On the Subject of Optical Technology: As many of you know, **Pinnacle Micro is having nothing but trouble** getting workable media for its 4.6GB Apex drive, which uses the new LIMDO (Light Intensity Modulation—Direct Overwrite) single-pass technology. Basically, this problem boils down to typical preannouncement games that have forced customers to wait for "better and cheaper" technology rather than buying what's already available. If Pinnacle can't get this working now, how the heck are companies going to ship the 4.7GB DVD drives this summer? □

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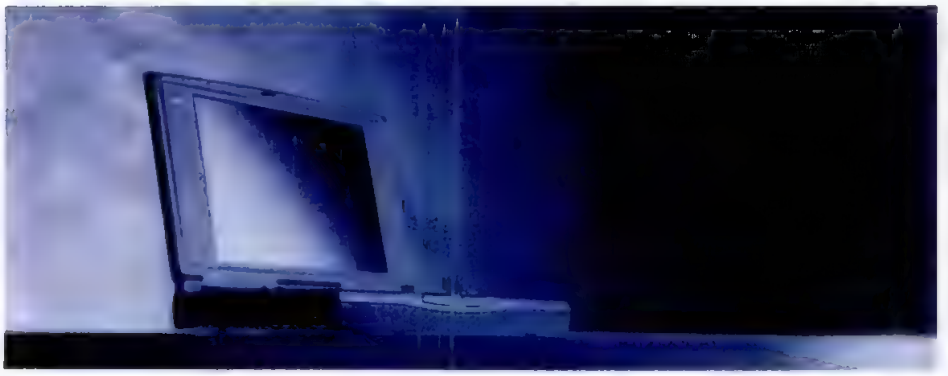

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(It also occurred to us you might want other options.)

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CIRCLE 087 ON READER SERVICE CARD

JIM SEYMOUR

The Hands-On Approach to Web Design

Working on Big Projects is always fun. Since the dawn of the Internet/intranet boom, I've had a great time helping big-time corporate clients plan and build big-time Web sites. Whether we intended them for public or internal use, we've often pushed these sites to the limits in terms of what you can do with site design, graphics, Java bulletins, fancy searching, downloads, and the rest of the fabled riches of the Web. Sometimes we've hired external site-design firms to implement our ideas; sometimes we've worked with in-house people assigned—usually temporarily—to produce the copy and the art, and to code the site.

Either way, it's very satisfying to camp out in a conference room for a few days to plan these sites, return several times to see what the folks in the back room have done since the last session, and finally watch your ideas and sketches turn into pixels, pages, rich sites.

But it's not nearly the same thing as Doing It Yourself. Getting your hands dirty in HTML and frames and marquees and browser-to-browser incompatibilities provides a certain...umm... *perspective* that is lacking when your site-design and site-management work is done in conference rooms on whiteboards. It's a lot easier to be glib about how simple Web page features are to implement—and how useful they'll be—when you're not the one who's going to be doing the work or using the site.

PERSONAL TOUCH

Getting your hands dirty in HTML provides a certain perspective.

This was something I recently learned, or perhaps relearned, when I built a prototype public Web site for a nonprofit client. Entirely by myself. One man, one site. Nothing heroic there, of course—hundreds of thousands of people have constructed their own Web sites, many no doubt richer and more elaborate than the one I built.

But in my case, part of the trick was to design a site I could then hand off to a small group of volunteers, who would replace my dummy text and photos with live text and pictures, all fitted within the de facto template I was building. None of those people were Web experts—or likely to become experts. So designing the site, including choosing the tools for building and revising it, involved zillions of decisions that would make the site easy to refresh, maintain, and extend. Indeed, a large part of the success or failure of my work would depend on whether I built something they *could* easily maintain and expand on their own.

The good news is that it worked out fine. The better news, for me at least, is that the extended bout of hands-on work has made me, I think, a lot better at doing the front-end planning stuff. Especially in terms of maintainability—I've argued for many moons that the biggest shortcoming of most Web site designs is that they are far more difficult and expensive to maintain and update than they ought to be. I find myself giving a lot more thought to sustainable structure and the real-world usefulness of features we're considering building into sites.

A good analogy would be to manufacturers with enlightened design-to-build programs. If the people who are actually going to build the engines, refrigerators, keyboards, and so on have a seat at the table when those products are being designed, they're likely to deliver better products, with far fewer production-line snafus and post-sale support problems, than when design isn't intimately linked to usability, buildability, and serviceability.

I'm not going to change my life, take the cybermonk's hood, and devote my days and nights to Perl scripts, but the experience did get me thinking. It also reminded me that what was once so may no longer be so, or at least may no longer be as important as it once was.

I was near the end of a training session on constructing Web graphics, along with the people who are going to maintain this site. I'd been preaching "smaller is better, tiny is best" over and over, and we'd gone through several exercises on reducing the file size of graphics—limiting the palette of indexed colors again and again and wringing thousands, then hundreds of bytes at a pass out of already pretty small images.

"But is that still so important?" one of the group asked. "Of course!" I replied. "Small graphics are the Holy Grail of the site builder. Why, let me tell you about the time...." I stopped dead in my own tracks and listened to my own words, silly and obsolete words, bouncing around the

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room. It was embarrassing. My answer, and assumptions, were stuck somewhere in 1994, in a world of speedy 9.6- and 14.4-Kbps modems. I don't access the Web at those speeds today, and you probably don't either. But I was still stuck in yesterday's assumption that you'd better make sure all your graphics files are tiny. And then there's that essential text-only alternate version....

The world has changed. For example, more than 12 percent of the people visiting *PC Magazine*'s Web site come in on T1 lines. I find that figure staggeringly high. But six months from now it'll probably be 20 percent. In a year, what—a third?

So, sure, it's important not to be profligate on file sizes and to make graphics as small as is practical—but the definition of "practical" has changed powerfully over the past couple of years. This time next year, and again a year later, it will have changed that much more again. As average access speeds get higher, graphics-file sizes become less important. You don't want to freeze out people with modest connections, but you do want to aim your site at the fat middle-of-the-connection speed market. And even "modest" connections are getting faster.

It's worth noting that the middle of your market varies considerably from Web site to Web site. In this case, my nonprofit client is in the center of a prominent high-tech area, serving largely upper-middle-class, technically savvy users, in homes and offices where a 28.8-Kbps modem is the norm or maybe even below the norm. A significant percentage of these users have ISDN, and many are hooked up over fast LAN Web links. Clearly, small file size is not at the top of my client's Web page design priorities.

Again, we don't want to create a second, disadvantaged class of visitors to our Web sites, forced into a kind of time-warped digital ghetto, waiting endlessly for fat graphics to creep onto their screens. But neither do we want to limit ourselves—and the larger group of visitors to our sites—with outdated assumptions. The aim point keeps moving.

It's easy to get stuck in the past in this business—especially when "the past" is often only a few months old. And it's even easier to fall into the front-office trap of separating the thinking from the *doing*. College presidents who still teach a class a semester and sales VPs who still make sales calls, are onto something. Web site planners could learn from them. □

BILL HOWARD

PC Vendors: Perception vs. Reality

The most important hardware story that appears in *PC Magazine* may well be our annual Service & Reliability report on desktop and portable PCs. The good news is that users are generally satisfied with the service, reliability, and technical support they get from PC vendors. On a scale from one to ten, ranging from least to most satisfied, the scores averaged between seven and eight. Four desktop and two portable PC vendors earned the top grade of A, based on above-average scores in four categories: reliability, tech support, repair experience, and repair frequency.

The desktop PC vendors with grades of A are Compaq, Dell, Hewlett-Packard, and IBM. Among portables, top marks went to Compaq and Toshiba. (For more details, see "Readers Rate Service & Reliability," in this issue.)

In previous surveys, the top-rated vendors were most often from the ranks of mainstream, retail-oriented vendors and major direct (mail-order) vendors. A year ago, when we enhanced the grading process by adding a question about repair frequency (as opposed to the more subjective *satisfaction* with the repair experience), no direct vendor scored better than average on repair frequency; therefore, none earned a grade higher than B. This year, Dell has returned to the ranks of top-rated desktop vendors, earning an overall grade of A.

The trend I find most intriguing is how much our readers love Dell, Gateway 2000, and Micron—the biggest and most talked-about mail-order vendors. Gateway and Micron earned grades of B for desktop PCs, with above-average scores in most categories except repair frequency, for which they received average marks. But what's most interesting is that sometimes these companies are beloved in spite of themselves.

Take telephone support, for instance. On the average, survey respondents said they waited 14 minutes before reaching a human being. With Micron, the reported wait was 19 minutes. Readers said it took 17 minutes to reach a technical-support person at Gateway. And at 13 minutes, Dell's hold time was average. (One caveat: Don't try to read too much into the raw numbers.)

And when desktop PC repairs were needed, Gateway and Micron were far more likely to send you a part and far less likely to dispatch a service technician bearing a replacement part than were other vendors we surveyed. On the average, for the desktop brands we surveyed, a repair part was sent 26 percent of the time and a repair technician was dispatched 29 percent of the time—the two most common responses from vendors. By contrast, respondents said Gateway and Micron sent replacement parts 50 and 51 percent of the time and dispatched a technician 13 and 17 percent of the time, respectively.

PR COUP

Vendors that do good jobs marketing themselves build reservoirs of goodwill.

Although many users enjoy the challenge of fixing their PCs once in a while, the excitement wears off quickly. So you'd think users would be less inclined to buy from a vendor that keeps them on hold and then asks them to fix the machine themselves. Apparently that's not the case.

When we asked subscribers whether they would buy another PC from the same vendor, on a scale of 1 (least likely) to 10 (most likely), the average responses were 5.8 for desktop PC owners and 6.6 for owners of portables. By contrast, Dell, Gateway, and Micron garnered ratings of 8.1, 8.1, and 8.8 respectively—the only buy-again ratings for desktop PCs above 8. We found similar contradictions between satisfaction with repair experience (rated as very high for Dell, Gateway, and Micron) and actual repair frequency (graded as average for Gateway and Micron, better than average for Dell).

This has all the makings of a pop-psychology book: *Vendors That Don't Always Come When You Call and the Users Who Love Them*. But the real answer to these puzzling results may be that vendors that do good jobs marketing themselves build reservoirs of goodwill. As a result, their customers are willing to put up with a few extra minutes on hold or to attempt their own repairs. This phenomenon occurs in other markets, too, but it takes a lot of work. For example, Saturn buyers seem to like their cars more than the cars' actual reliability records would merit.

Of all the categories we survey, I look most carefully at the buy-again ratings. The answers to that question synthesize overall satisfaction with the brand, perceived affordability, and perceived likelihood that the vendor will be a player in the business down the road. Vendors that score worse than average on this measure should do some soul-searching. □

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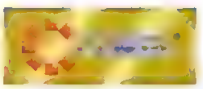

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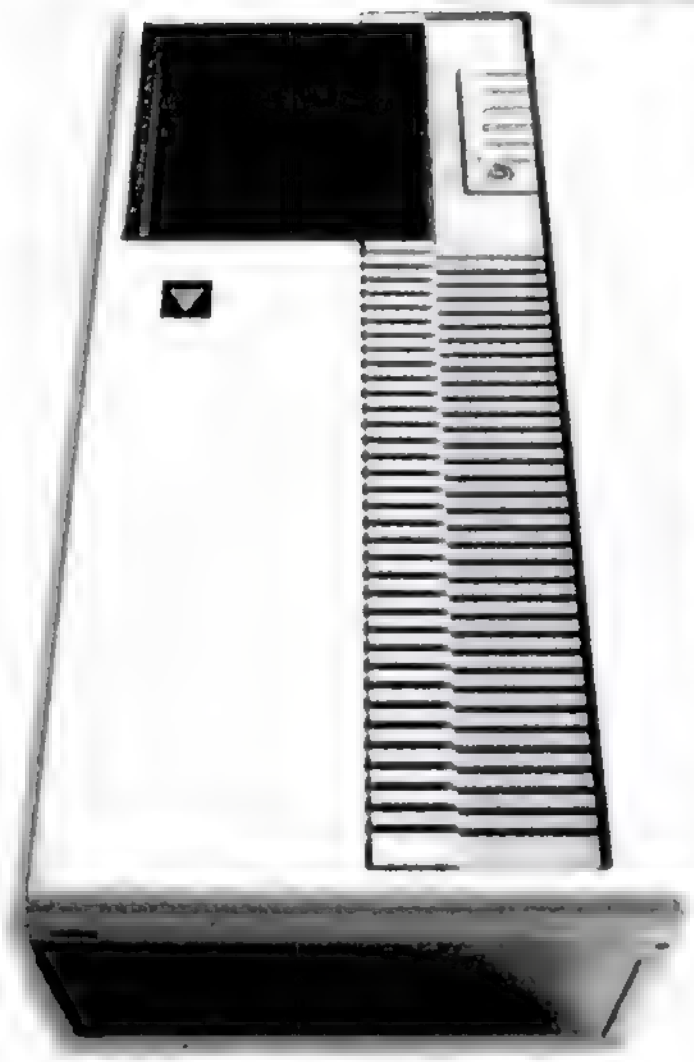

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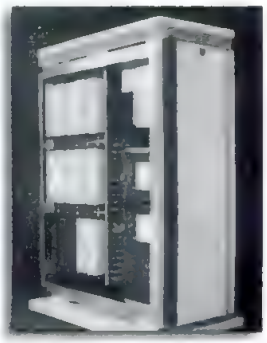

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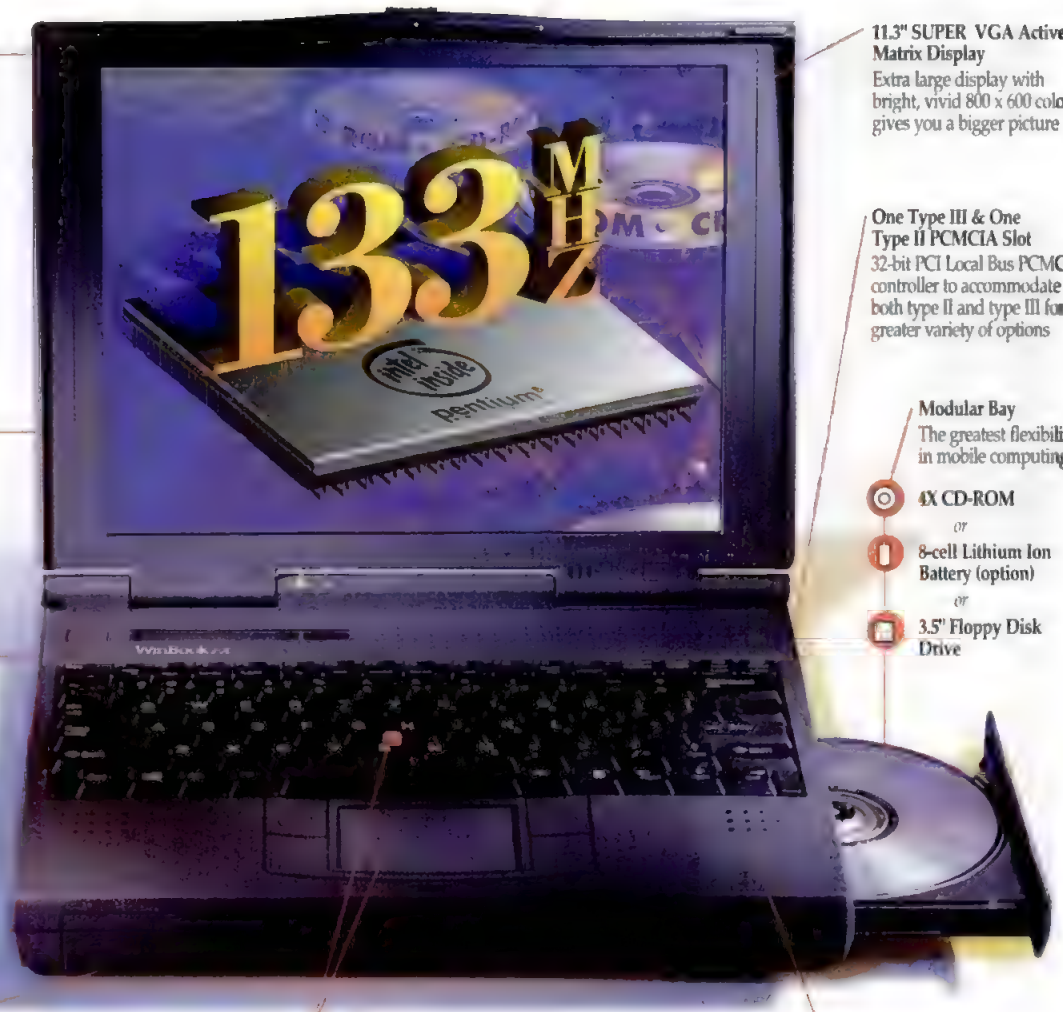

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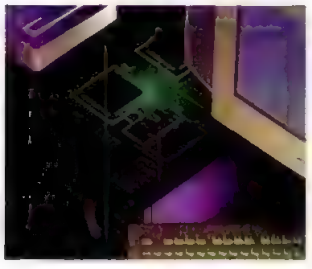
THE PERFECT PC



By Michael J. Miller • What is a Perfect PC? At *PC Magazine*, we've maintained that no one make or model fits that description for everyone. In the pages that follow, you'll see 13 versions of an idealized Perfect PC. In case you're more into assembling a machine from the ground up, we've also included a section on the perfect components.

In our Perfect Connections section, we'll show you the best connections for office, mobile, and home use.

And later in the issue, you'll find our latest survey of PC Service and Reliability as well as Software Support and Satisfaction, plus the *PC Magazine* 150, our listing of the largest vendors in particular categories.

ILLUSTRATIONS BY VISUAL LOGIC/JACK HARRIS

THE PERFECT PC

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THE PERFECT CONNECTIONS

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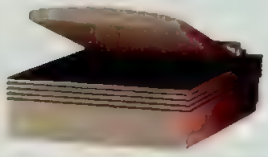
Peripherals *If your work is graphics-intensive, add peripherals to your Dream System that will complement your work, starting with a high-resolution color flatbed scanner and a color laser printer.*



Color flatbed scanner: 600 by 600 dpi optical, 1,200 by 1,200 dpi interpolated, 24-bit color minimum. Price: about $3,000

Color laser printer: 600 dpi; 3 ppm; supports PostScript Levels 1 and 2; PCL 5; 8MB RAM minimum. Price: $5,000 and up

Technologies to Watch

Multimedia extensions will be added to future CPUs to boost graphics and video performance. Look for Intel's P55C, AMD's K6, and Cyrix's M2

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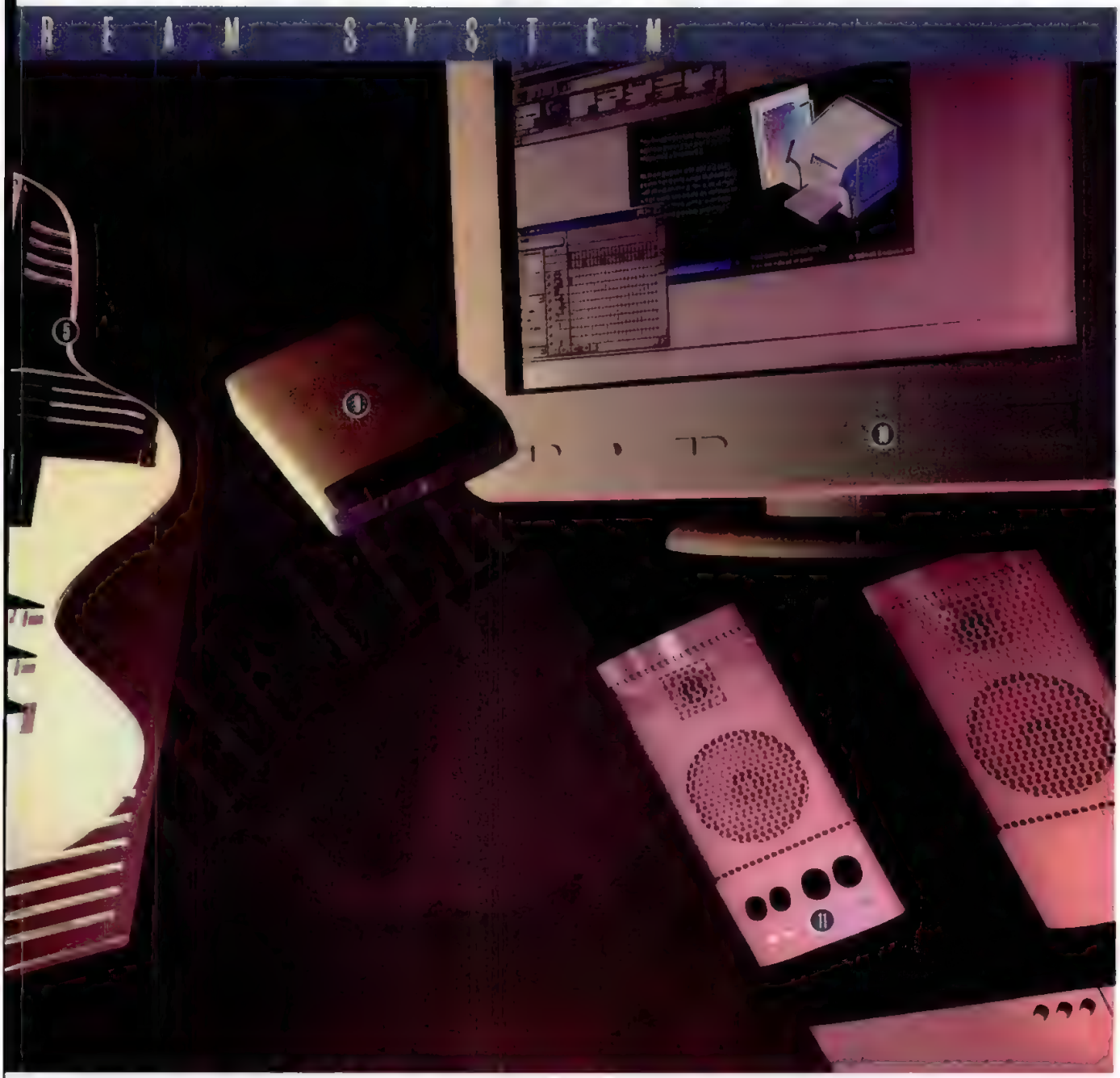
1. **8X CD-ROM drive.** Pick a drive that uses a true 8X mechanism—not a 4X on software steroids.
2. **A DAT (4-mm) drive** to back up important files; capacity should closely track hard disk capacity.
3. **A 120MB floppy disk drive:** backward-compatible with your old 1.44MB disks.
4. **Universal Serial Bus support** to attach up to 127 devices, including keyboard and mouse.
5. **A 200-watt power supply** will ensure that you have enough power to connect more devices. Also purchase a **450-va UPS** to protect data in the event of a power outage
6. **A PCI graphics board with 4MB of RAM** for 1,280-by-1,024 24-bit color; VESA connector for 4MB of extra RAM (for 1,600-by-1,280 24-bit color); TV tuner or MPEG module.
7. **A 32-bit sound board** that includes wavetable and FM-synthesis support. It should also be Sound Blaster–compatible for games.



8. **A 10/100-Mbps PCI Ethernet card** for fast connections to your LAN

9. **An ISDN modem** for speedy external connections; all you need is an ISDN phone line

10. **A 21-inch monitor** supporting 1,280-by-1,024 resolution at a refresh rate of 75 Hz or better. For 1,600-by-1,200 true color, you'll need at least 6MB of graphics-card memory

11. **Speakers (20 watts per channel) with subwoofer** will provide high-quality audio

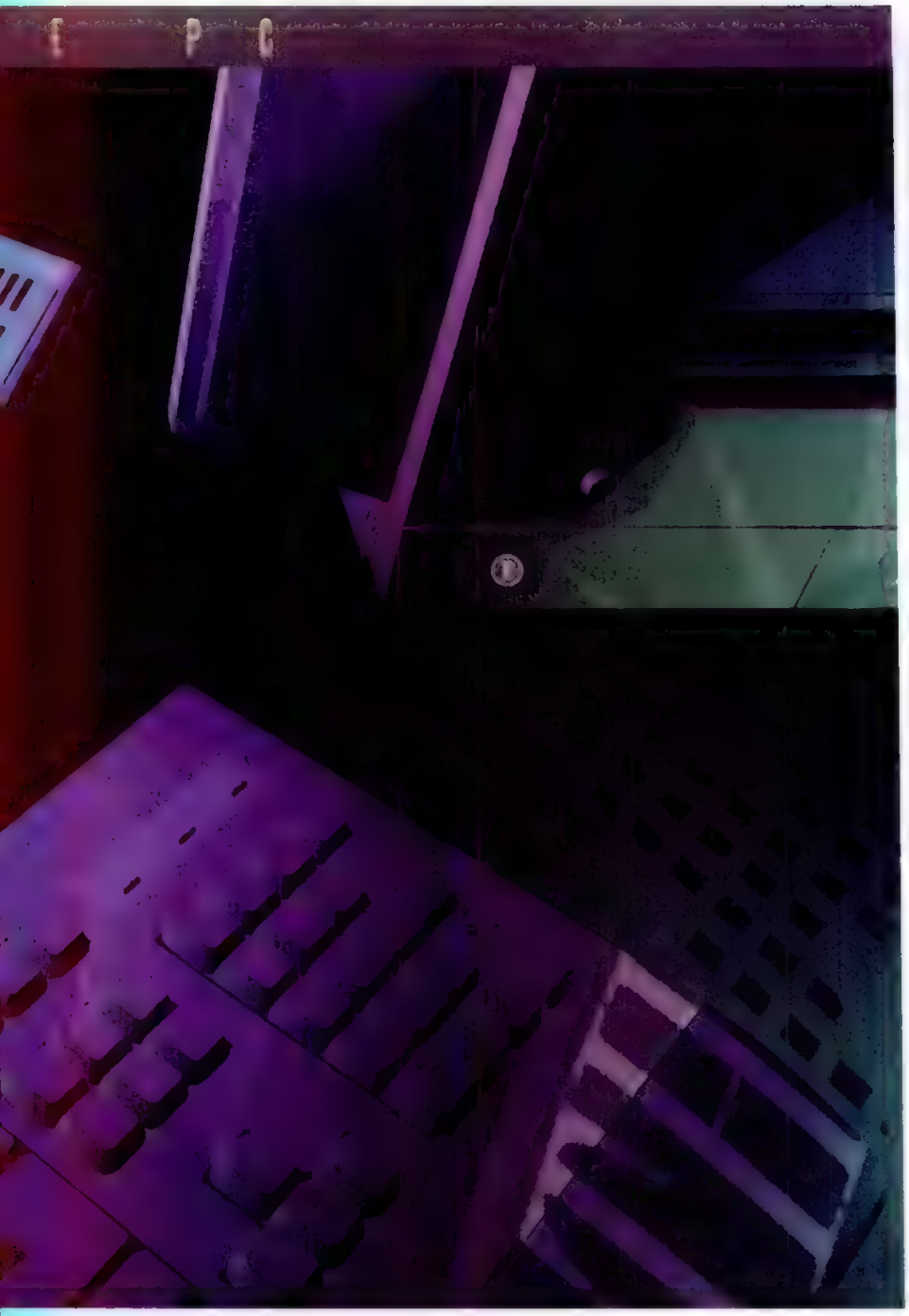
If Your Perfect Operating System Is...

	Windows 95 or OS/2 Warp Connect	Windows NT Workstation 3.51
A	200-MHz Pentium processor	200-MHz Pentium Pro, dual-processor–upgradable
B	512K of synchronous L2 cache	256K of integrated L2 cache
C	32MB EDO or synchronous DRAM	64MB EDO or synchronous DRAM
D	4GB Fast/Wide SCSI-2 hard disk	4GB Fast/Wide SCSI-2 hard disk

THE BASIC WORKHORSE

The configuration for an office PC can vary widely, depending on user needs. For basic word processing and e-mail functions under Windows 95 or Windows 3.x, a 133-MHz Pentium should suffice. DMI compliance is also a must for the office PC. Price: About $2,500.

1. **The desktop case** should provide plenty of expansion space for this type of PC.
2. **A quad-speed CD-ROM drive** is a bare-minimum must for any PC.
3. **A 3.5-inch floppy disk drive** is standard equipment for any PC.
4. **A 145-watt power supply** will provide plenty of juice for the office PC.
5. **A PCI graphics accelerator card** with a minimum of 2MB of RAM (1,024-by-768 true color will require 4MB of RAM).
6. **A 133-MHz Pentium CPU,** today's sweet spot for a cost-conscious PC, has enough power for basic business apps. If you need more power, a P/166 is only a few hundred dollars more.
7. **256K of synchronous L2 cache** is a necessity for any PC to ensure good performance.



8. **16MB of RAM.** Windows 95 won't be happy with any less, and you'll be in a better position to upgrade to Windows NT in the future
9. **A 10/100-Mbps Ethernet card.** Pricing dictates that it no longer makes sense to purchase a 10-Mbps network card.
10. **A 16-bit wavetable sound board** that's also Sound Blaster–compatible will provide basic audio capabilities for voice-annotating documents.
11. **A keyboard** with wrist rest, available with either silent or "click" keys.
12. **A 1.2GB Enhanced IDE hard disk** will provide ample storage space for office automation tasks
13. **A 17-inch monitor** for 800-by-600 or 1,024-by-768 resolution. Built-in speakers minimize clutter
14. **A personal scanner** for scanning important documents or news releases

High-End Upgrade

For serious users who need more power than the basic office PC can provide:

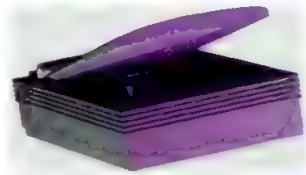
- Windows NT Workstation 3.51.
- Pentium/166 CPU.
- 32MB RAM.
- 2.5GB EIDE or larger hard disk.
- Minitower case.

Total system price: About $3,500.

Graphics Upgrade

Graphic artists require more sophisticated hardware to do their jobs. Total system price (including peripherals below): About $30,000.

- Windows NT Workstation 3.51.
- Pentium/200 or Pentium Pro CPU.
- 64MB RAM.
- 4GB Fast/Wide SCSI-2 hard disk.
- Mini-tower case.
- 21-inch monitor; 8MB graphics-card RAM.
- Video capture board.



- 600-by-600 optical, color flatbed scanner.

- Removable storage system, as from SyQuest.

- Digitizing tablet.

- Thermal dye transfer printer, capable of Super B–size prints.

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and combinations thereof. Run With
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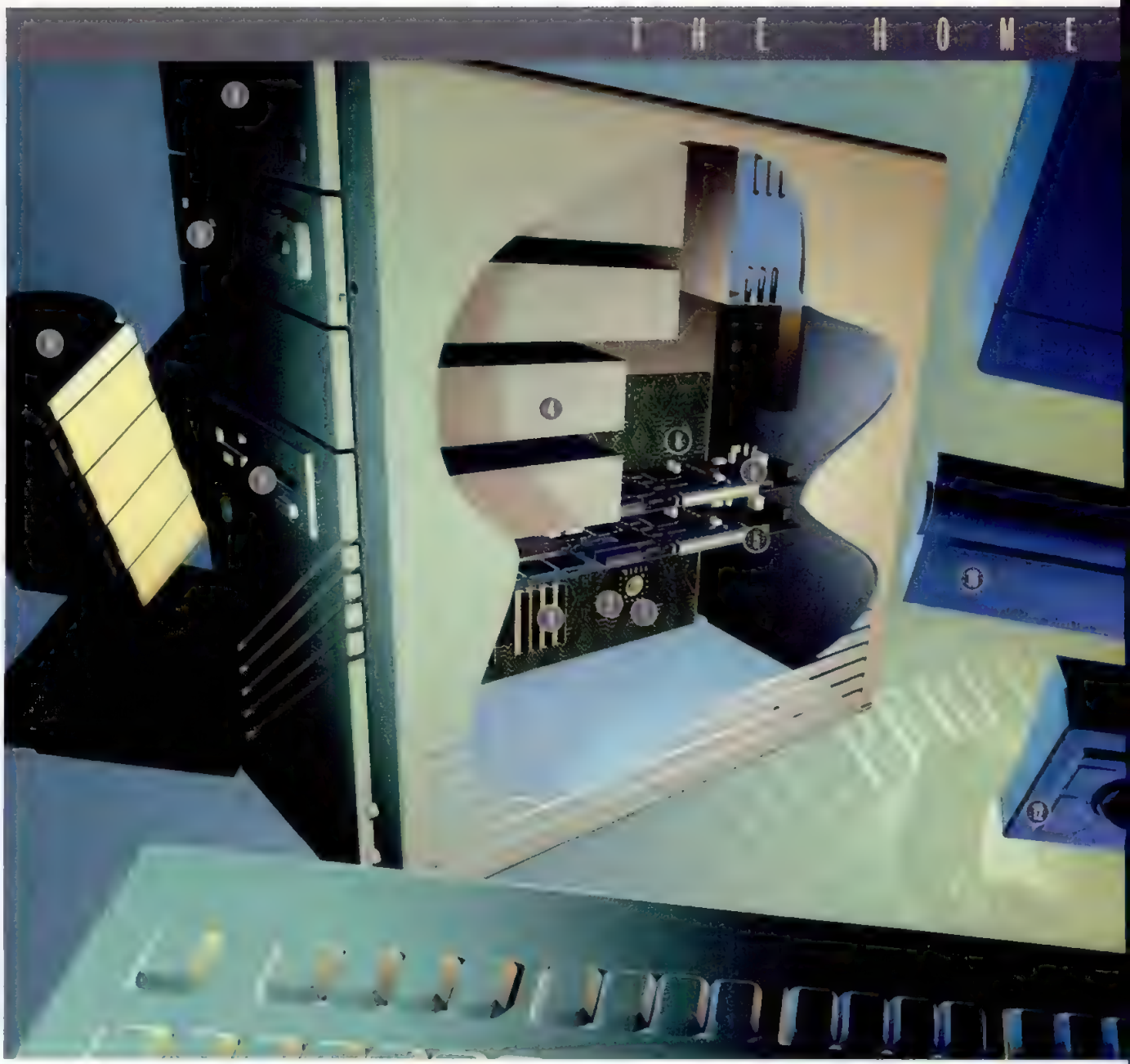
CIRCLE 075 ON READER SERVICE CARD



Technologies to Watch

DVD (Digital Versatile—or Video—Disk). An emerging standard, DVD drives likely won't appear on home PCs before the end of the year

P55C CPU with MMX. A 200-MHz Pentium with multimedia extensions should speed video performance. Target ship date fourth quarter 1996. Cyrix and AMD should also have multimedia-enhanced CPUs in the same time frame

"MULTIFUNCTION" DEVICE

Today's home PC is no longer a single-function system: It's an edutainment machine for the kids, as well as a work-at-home PC and part-time DTP system for parents. Before buying your perfect home PC, make sure to take the needs of your entire family into consideration. Our basic machine, pictured above, should get you started. Price: $3,500.

1. **A Pentium/166 CPU** will give you the power you need; consider a Pentium/200 for about $250 more
2. **256K synchronous L2 cache is a must for any PC** and adds only about $50 to $100 to the price. Avoid cacheless configurations—system performance will suffer.
3. **16MB EDO DRAM** is a minimum for Windows 95
4. **A 2GB EIDE hard disk** should ensure that you won't run out of disk space in the near future
5. **32-bit wavetable sound card:** Sound Blaster–compatible for games

6 **28.8-Kbps modem:** Supports full-duplex speakerphone and voice-mail functions

7 **17-inch monitor.** For 1,024-by-768 true color, you'll need a 4MB graphics card; a 15-inch monitor requires 2MB of RAM for 800-by-600 resolution

8 **Universal Serial Bus (USB) support** for upcoming peripherals

9 **A 6X CD-ROM** drive is standard issue on most PCs today; 8X versions are also available

10 **A Zip drive** provides about 100MB of data storage. Consider a Travan drive for up to 4GB of storage

11 **3.5-inch, 1.44MB floppy disk drive;** consider an LS-120 drive for 120MB of additional storage

12 **A large trackball** is a great pointing device that's easy for all family members to use

13 **A four-color ink jet printer and a personal scanner** will add about $700 (total) to the cost of your new PC

14 **Powered speakers** with subwoofer

15 **An uninterruptible power supply** will prevent data loss in the event of a power outage

Gamers' Peripherals

If you or your kids are gaming enthusiasts, the peripherals and components described below should bring you one step closer to turning your living room into a PC-based arcade.

- A joystick is a must for the serious gamer.

- Consider two arcade-style game pads for head-to-head competition.

- 3-D surround-sound speakers with a sub-woofer will provide realistic audio.

- A 17-inch monitor with a 4MB graphics card will support 1,024-by-768 true color.

- Look for an 8X CD-ROM with a true 8X engine, not a pumped-up 4X or 6X drive.

Fast Connections

Consider an ISDN modem for fast Internet access. You'll need an ISDN phone line and service provider as well. See our "Perfect Service Provider" section in this issue for more information.

*Estimated selling price for Bravo LC 5100 model 635W. Actual prices may vary. Contact your reseller for details. ©1996 AST Research, Inc. AST is a registered trademark of AST Research, Inc. Intel, Pentium and the Intel Inside logo

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Bravo MS: *Intel 430HX PCIset, Pentium® processors, Pipeline Burst cache, EDO RAM, 64-bit ATI mach 64 VT graphics, synchronous graphics RAM, integrated 16-bit audio.*

Bravo LC: *Pentium processors, 256 KB second-level cache, EDO RAM, integrated 64-bit PCI-based graphics.*

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CIRCLE 122 ON READER SERVICE CARD

OUTFITTING THE HOME OFFICE

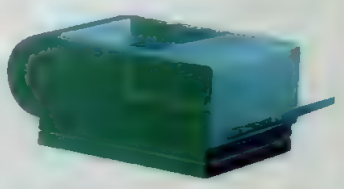
Whether you run a business from home, work from home occasionally, or do volunteer work, you'll need to receive faxes, make photocopies, and handle phone calls. Although a PC can do all of this, standalone fax machines, copiers, and answering machines represent proven, reliable technology that anyone can use.

1. **Videoconferencing system** should comply with the H.320 standard for video teleconferencing.
2. **Standalone fax machine** can also double as a copier and is more reliable than a PC fax.
3. **Copier** for top-notch paper-handling flexibility and high-volume output.
4. **An answering machine** provides a vital outside link: It shouldn't be considered a cost-saving item.

For Desktop Publishing

If you need sophisticated graphics output support for producing multiple, high-quality originals or if your work demands more than the average four-color ink jet can deliver, consider the options below.

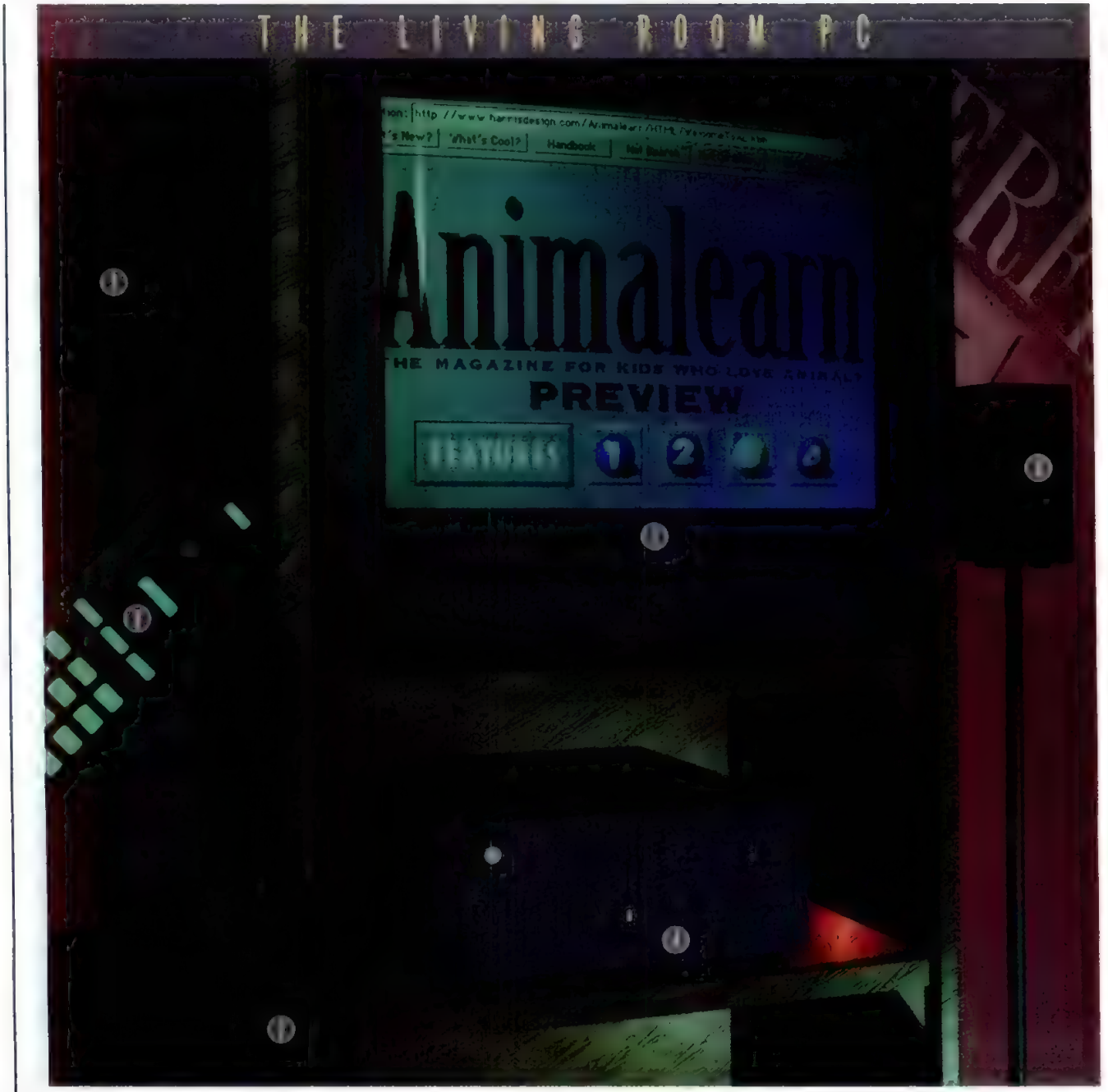
- Flatbed color scanner. Price: $500 to $1,500. For faster 32-bit performance for graphics professionals: $2,500



- Personal laser printer, 4 to 6 ppm, 600 dpi, for proofs or camera-ready masters. Price: $400 to $500

- Four-color ink jet printer. Price: $600 to $700. For graphics professionals, look for an ink jet that can produce tabloid-sized pages. Price: $2,000

- Color laser printer, for consultants and others producing handouts or proposals. Price: $5,000+.



PC+TV *Can't decide whether to purchase a new computer or a new television set? You don't have to choose between the two anymore: As more system vendors sell Pentium PCs equipped with large monitors, fast modems, cable- and broadcast-ready TV tuners, and wireless accessories, the PC and the television are beginning to converge.* Price: $3,500 to $4,500.

System features:

1. **31-inch or larger VGA monitor.** For the time being, you'll likely have to settle for VGA-level resolution from your big-screen PC/TV.
2. **Wireless keyboard and remote** (RF or infrared), both with built-in pointing device such as touch pad or trackball.
3. **Dolby ProLogic surround-sound speaker system** (add-on cost, about $1,000, including receiver) for the true home-theater experience.

PC features:

4. **133-MHz or faster Pentium CPU.** If you plan to use your PC/TV for more computer-intensive tasks, consider a Pentium/166 CPU.

Additional PC features:

- TV tuner; receives broadcast and cable.
- 28.8-Kbps DSVD modem or ISDN modem.
- 1GB hard disk or better.
- 16MB EDO DRAM.
- Windows 95.

MOBILE POWERHOUSE

Our perfect desktop replacement notebook provides all the features, functionality, and flexibility that you'll need for no-compromise computing on the road, whether you're creating presentations or crunching spreadsheets. Add a docking station for full workstation support when you're in the office. Price: $6,000 to $8,000.

1. **12.1-inch SVGA active-matrix display** supports 800-by-600 resolution; notebooks that support XGA (1,024-by-768) are also available
2. **Two integrated speakers** with audio-out for use with larger speakers. Also look for a system with a full-duplex microphone, which will allow you to use your notebook as a speakerphone
3. **System status panel** shows battery charge level, among other system features and functions
4. **Full-size (19-mm) keyboard** with Windows 95 hotkeys; cursor keys in inverted-T layout.
5. **Two Type II PC Card slots,** stacked one on top of the other, will also accept one Type III PC Card device. Some notebooks also support CardBus, a high-end extension to the PCMCIA standard.
6. **6X CD-ROM drive,** removable and swappable for a floppy disk drive, a second battery, or a second hard disk
7. **1.3GB or 2GB Enhanced IDE hard disk,** removable and user-upgradable
8. **Lithium-ion battery pack.** Your system should accept a second battery for maximum life.

9 **Volume-control thumbwheel,** line-in/line-out jacks, speaker and microphone jacks

10 **Integrated pointing device.** You'll find pointing sticks or touchpads on most notebooks of this class

Docking station features:

11 **5.25-inch drive bay** for an additional device, such as a tape-backup drive

12 **Two additional Type II PC Card slots.**

13 **Security lock** to prevent notebook theft

Additional dock features:

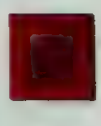
- Two built-in speakers provide sound superior to notebook's integrated speakers
- Duplicate ports
- PCI and/or ISA expansion slots
- SCSI-2 connector
- 10/100-Mbps Fast Ethernet connection

Inside the notebook:

- 133-MHz Pentium CPU with Voltage Reduction Technology
- 256K synchronous or pipelined-burst L2 cache
- 64-bit PCI graphics with 2MB RAM
- 24MB EDO or synchronous DRAM
- 16-bit wavetable sound.

Port Guide *The road warrior's portable powerhouse should provide the following connections, as a minimum:*

- Integrated 28.8-Kbps modem: supports fax, full-duplex speakerphone, answering machine, and voice-mail.



- Fast infrared (FIR): supports infrared transfers of up to 4 Mbps.

- External VGA port.

- Serial port.

- Docking station port

- NTSC video in/out: a must for the mobile presenter to hook the notebook up to a television set using an RCA jack.

- Parallel port

- Security slot to deter theft

Technologies to Watch

CardBus: A high-end extension to the PCMCIA standard; provides 32-bit data path, 3.3-volt operation, synchronous operation up to 33 MHz, and "hot-insertion" capabilities.

Zoomed Video (ZV) Port. Another extension to PCMCIA standard, the ZV Port will allow video to stream directly from the PCMCIA socket adapter to the graphics controller and video frame buffer, bypassing CPU and system bus. Ideal for video capture and teleconferencing applications.

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DELL DIMENSION™ XPS Pro200n
200MHz PENTIUM® PRO PROCESSOR

- Mini Tower Model
- 16MB EDO Memory
- 256KB Internal L2 Cache
- 2.5GB Hard Drive (10.5ms)
- 15TX Trinitron Monitor (13.7" v.i.s.)
- 9FX Motion Graphics Accelerator with 2MB VRAM
- 8X EIDE CD-ROM Drive
- MS® Office Professional with Bookshelf for Windows® 95
- Microsoft® Windows 95/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty†
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133MHz PENTIUM PROCESSOR

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- 256KB Pipeline Burst Cache
- 1.6GB Hard Drive (10ms)
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- 64-bit PCI 1MB DRAM Video
- 4X EIDE CD-ROM Drive
- Microsoft Windows 95/30 Days Free Support/Dell Mouse
- 3 Year Limited Warranty
- ★ *3Com® EtherLink® Interface Combo Card, add $99*
- ★ *28.8 Data/Fax Modem, add $129*
- ★ *ACS-31 Speakers and AWE32 Sound Card, add $219*

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200MHz PENTIUM PROCESSOR

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- 16MB SDRAM Memory
- 256KB Pipeline Burst Cache
- 1.6GB Hard Drive (10ms)
- 15TX Trinitron Monitor (13.7" v.i.s.)
- 9FX Motion Graphics Accelerator with 2MB VRAM
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- Integrated Sound Blaster 16 Sound
- Altec Lansing ACS-5 Speakers
- Microsoft Windows 95/30 Days Free Support/MS Mouse
- 3 Year Limited Warranty
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- Microsoft Windows 95/30 Days Free Support/Dell Mouse
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Dell's featured computer artist is Nance Paternoster of San Francisco, CA.

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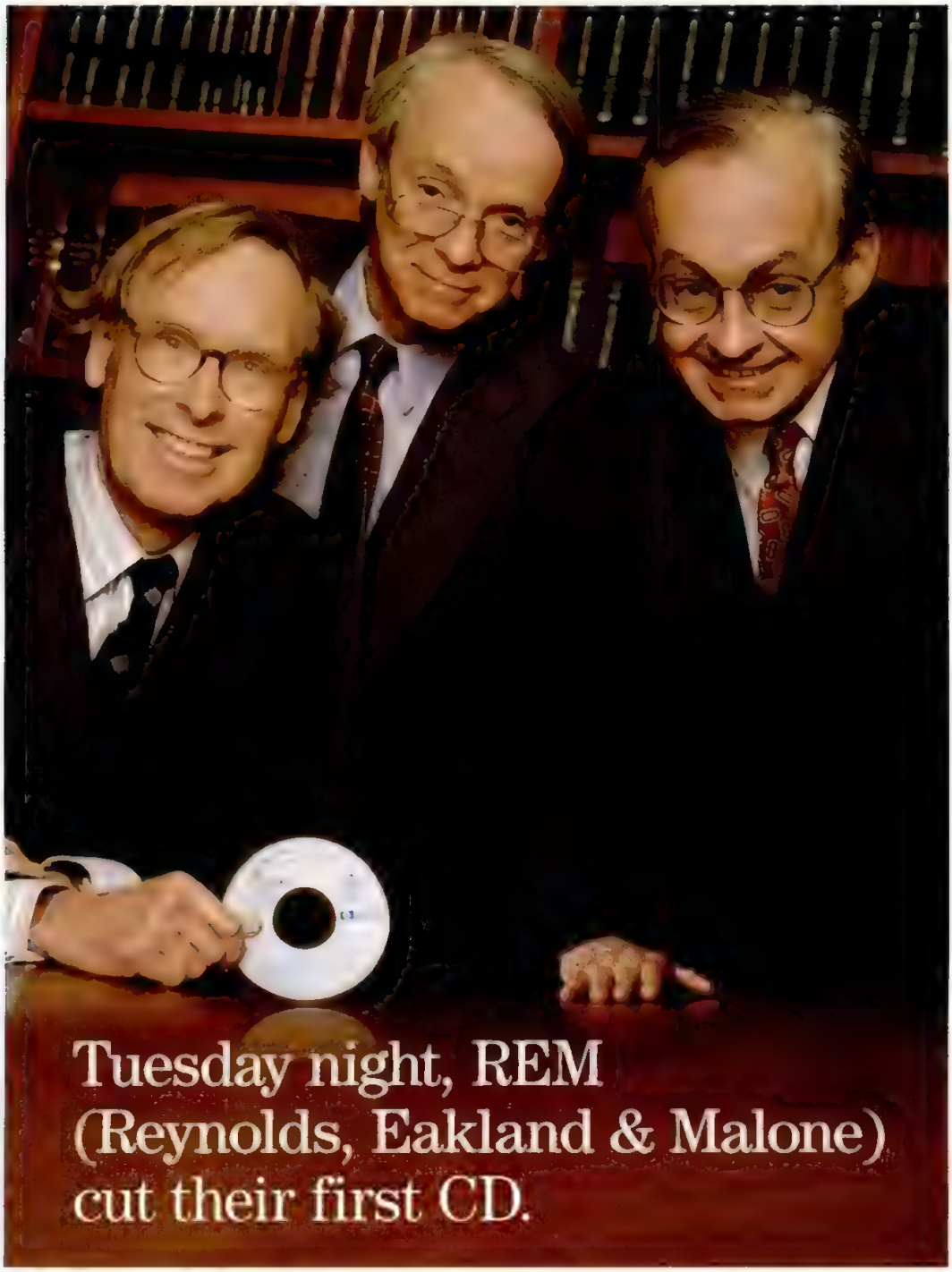

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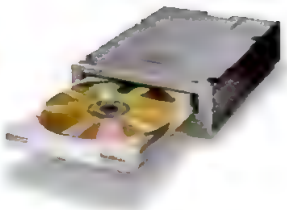

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The verdict is in. HP SureStore CD-Writer is the way to cut it in business. For more information, call 1-800-826-4111, extension 1482.

CIRCLE 073 ON READER SERVICE CARD

AFFORDABLE FUNCTIONALITY

Inside the perfect value notebook, you'll find a Pentium/100 CPU, 16MB of RAM, 32-bit PCI graphics with at least 1MB of RAM, an 800MB or larger hard disk, 16-bit sound, and an integrated 28.8-Kbps modem. Price: About $2,500.

1. **10.4-inch active-matrix or 11.3-inch dual-scan display,** if you need a larger screen.
2. **Two speakers and microphone.**
3. **Two stacked Type II PC Card slots:** Will accept a single Type III device.
4. **Removable 4X CD-ROM drive,** replaceable with 3.5-inch floppy disk drive.
5. **Nickel-hydride or lithium-ion battery.**
6. **Integrated pointing device:** Touchpad or pointing stick.

Port Replicator

This device duplicates all ports for use with external monitor and other devices when you're stationary. Price: About $99; with integrated 10-Mbps Ethernet, $199.

A. Parallel port C. VGA port E. Mouse port
B. Serial port D. Keyboard port

The new SENS™ 810. The keyboard is just one of the features you'll love to get your hands on.

SENS™ 810 PENTIUM® PROCESSOR	100 MHZ	100 MHZ	120 MHZ	133 MHZ
RAM	8 MB	8 MB	16 MB	16 MB
HDD	810 MB	1.3 GB	1.3 GB	2.1 GB
DISPLAY	11.3" SVGA Dual Scan Color	12.1" SVGA Active Matrix Color	12.1" SVGA Active Matrix Color	12.1" SVGA Active Matrix Color
CD-ROM	4x CD-ROM	6x CD-ROM	6x CD-ROM	6x CD-ROM
BATTERY	Lithium Ion	Lithium Ion	Lithium Ion	Lithium Ion
MODEM	—	—	—	28.8 Kbps Fax Modem
WARRANTY	3 year	3 year	3 year	3 year
PRICE *BUSINESS LEASE*	**$2,999** *$120 per month*	**$3,799** *$140 per month*	**$4,299** *$159 per month*	**$4,999** *$184 per month*

FREE Mini-Dock Docking Station with purchase of SENS™ 810 while supplies last.

SENS™ 800 *(not pictured)* PENTIUM® PROCESSOR	75 MHZ	100 MHZ
RAM	8 MB	8 MB
HDD	520 MB	810 MB
DISPLAY	10.4" SVGA Dual Scan Color	10.4" Active Matrix Color
WARRANTY	3 year	3 year
PRICE *BUSINESS LEASE*	**$1,799** *$72 per month*	**$1,999** *$80 per month*

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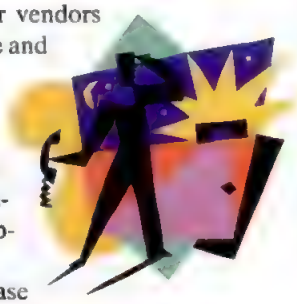
CIRCLE 033 ON READER SERVICE CARD

How to Buy the Perfect PC

Buying a new PC for your home or office can be confusing. Today's PC market is vast, offering a system for virtually everyone, regardless of computing needs or budget. The section below will help get you started; before you begin shopping fill out the Buyers' Worksheet that follows. If you're considering upgrading your old PC, or can't decide where to spend those extra few dollars on a new PC, consult the inside of this foldout.

Before you begin your PC buying expedition, ask yourself three questions: What do I want to do with my new PC? How much money do I want to spend? And how comfortable am I tinkering with computers? The answers will narrow your choice of where to buy your PC. Different purchase channels specialize in different types of PCs and present a wide range of prices and services. Having an idea of the minimum levels of service and support you need from a vendor and what level of power you require should further narrow the field.

WHERE TO SHOP There are many different outlets where you can buy your PC, each specializing in different types of systems. If you're fairly well versed in computerese and know what you want, consider purchasing from a *direct vendor* (mail-order). Most mail-order vendors offer a wide range of hardware and software, and they'll usually custom-configure the PC to your specifications. Many direct vendors also have great deals on software, offering add-on bundles and multimedia upgrades, as well as printers.



You may choose to purchase your PC through a *computer retailer,* such as a computer superstore, electronics store, or office-supply outlet; they also offer large selections of hardware, software and peripherals. Be aware that their salespeople may not be well educated about the features of the computer products, so you should have a good idea of what you want before going. Many of these stores, however, have a separate section for volume or corporate accounts, where more help will be provided. Also keep in mind that although retailers' prices should be competitive, they may be higher than mail-order prices.

A *value-added reseller* (VAR) or a computer consultant can also supply a PC. If you're looking for a complete, turnkey solution, a VAR is an excellent choice. In addition to configuring systems to your specifications, many VARs will also provide installation and long-term maintenance services (for a fee, of course). Many can also provide integrated, networked solutions customized to fit your business's needs.

WHAT TO BUY Today's PC market is all Pentium-class and Pentium Pro. The sweet spot on the Intel processor scale today—if cost is a major consideration—is the 133-MHz Pentium. Not only does this CPU have the power to handle most of today's mainstream business applications, it can grow with you. If you're not so constrained by cost, consider a Pentium/166 or the newly released Pentium/200. But be aware that the latter has just come out of the gate, and the prices, though competitive, are still high. Keep in mind that you get better performance from a CPU that runs on a 66-MHz system bus (Pentium/100, 133, 166, or 200), than you do from a processor coupled to a 60-MHz bus (Pentium/120 or 150).

SERVICE, SUPPORT, AND WARRANTIES The service and support that a vendor offers are every bit as important as the hardware it sells, especially if you're not prepared to fix your PC yourself. Many vendors offer three-year warranties—a definite plus. Many also offer on-site service free for one year and additional years of service for a nominal fee.

Most PC vendors offer toll-free telephone technical support. Their hours vary widely, however, from 24 hours, 7 days a week to weekday business hours only. If you're buying a home PC and will be using it at night, a vendor with technical support only during business hours might not make sense. Corporate and volume customers should look for vendors offering a special support number, which will ensure a speedier response.

To measure the quality of vendors' service and technical support, as well as the reliability of the PCs that they sell, *PC Magazine* conducts its annual Service & Reliability survey of 17,000 subscribers. The results of our newest survey are contained later in this issue. Consult "Readers Rate Service & Reliability" to see how the vendors that you're considering stack up according to our subscribers.

BY CAROL VENEZIA

ILLUSTRATIONS BY DIANNE BENNETT

grade Guide

THE $300 QUESTION

Picture this: You're in a computer store and you've just paid for your new PC. There's great news: The total is $300 less than what you budgeted. After giving yourself a well-deserved pat on the back, you put the PC aside, stride back into the store, and start shopping anew. What can you do to improve your PC for $300 or less? Here are a few suggestions.

UPGRADE THE SOFTWARE Many PC vendors offer deeply discounted prices on extra or upgraded software packages if purchased at the same time as a PC.

BUY A LARGER MONITOR For $300 or less, you can easily upgrade from a 14- or 15-inch monitor to a 17-inch model. Just make sure the monitor's dot pitch is 0.28 mm or less.

LONGER WARRANTY If you don't know your way around the inside of a PC, extending your system's service or on-site warranty for an extra year or two might not be a bad idea.

MORE RAM 16MB is the bare minimum for comfortable operation under Windows 95. Remember also that memory upgrades are usually cheaper when done at the same time as a system purchase.

EXTRA VIDEO MEMORY Here again, while 2MB of video DRAM, VRAM, or other flavor of video memory is fine, upgrading to 4MB will greatly accelerate performance when dealing with full-motion video or high-resolution graphics. It will also allow you to have greater color depth.

BETTER AUDIO You can upgrade to a sound card that supports wavetable audio (or purchase a daughtercard to add wavetable capabilities to your sound board) and trade up to a three-piece speaker system with a subwoofer.

ERGONOMIC CHAIR You'll probably spend a good deal of your time by your computer; investing in a chair with proper support can save you pains in the future.

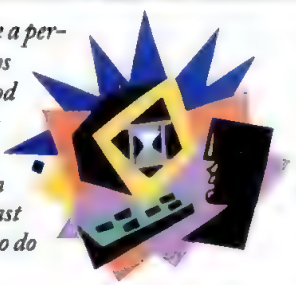
INK JET PRINTER A serviceable three- or four-color ink jet printer can be bought for $300 or less.

TAPE BACKUP SYSTEM OR ZIP DRIVE Both can safeguard your data, although a tape backup system may be slow. ZIP drives are also removable, an added convenience.

UNINTERRUPTIBLE POWER SUPPLY A UPS will protect your data in the event of a power failure. It may seem like overkill, but for any PC today—especially if you run your business on it—it's an indispensable peripheral.

PERSONAL SCANNER For less than $300, you can purchase a small monochrome scanner that takes up no more table space than a box of aluminum foil.

OPTIMIZING YOUR PC



Does that hourglass icon seem like a permanent fixture on your Windows 95 desktop? If so, chances are good that there's a setting or feature that you've neglected to enable, disable, or install on your PC. On the everlasting quest for that last ounce of performance, remember to do the following.

UPDATE YOUR DRIVERS Even new PCs may come with old 16-bit hardware drivers instead of more robust 32-bit versions. Check with manufacturers for the latest drivers.

DEFRAGMENT YOUR HARD DISK When DOS or Windows saves a file, it doesn't necessarily save it in one piece. A disk defragmenter will enhance disk performance and improve your chances of recovering deleted files.

USE THE PRIMARY IDE CHANNEL Make certain that your IDE hard disk is connected to the primary IDE channel of your hard disk controller or motherboard and not to the slower secondary channel. Also check your unit's BIOS setup screen (and your hard disk manual) to see if the primary IDE channel is set for the fastest data-transfer mode your hard disk can handle.

TURN OFF THE VIRTUAL DESKTOP Some graphics drivers allow you to use a higher resolution than your screen can handle by creating a virtual desktop—which takes up more graphics memory. In this mode, you can't view entire images at once, but you can easily move to all areas.

DECREASE COLOR DEPTH, SCREEN RESOLUTION, OR BOTH High screen resolutions and especially high color depths can slow graphics performance.

EXAMINE HARD DISK SETTINGS While the 32-bit disk access available in Windows 3.*x* offers minor performance benefits, Windows for Workgroups 3.11 and Windows NT offer 32-bit-file access, which truly enhances disk performance. Check the Control Panel to see if these features are enabled. (Some software utilities conflict with 32-bit disk access, so check first.) Windows 95 uses 32-bit disk drivers by default.

OPTIMIZE VIRTUAL MEMORY Let Windows 95 manage virtual memory for the best performance. Use the maximum suggested settings in Windows 3.*x* where possible.

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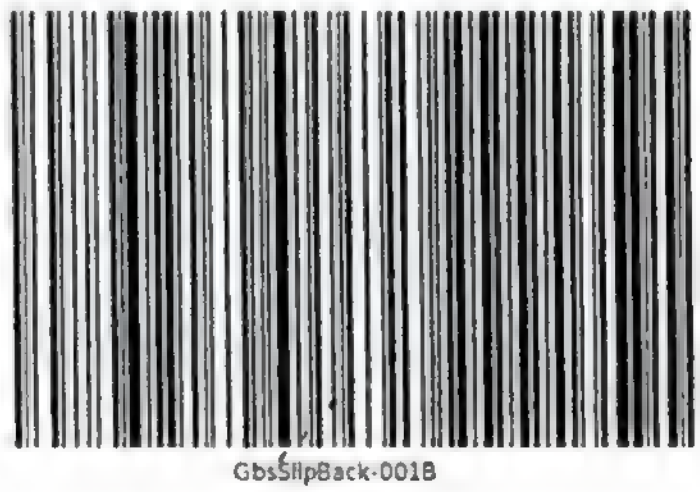

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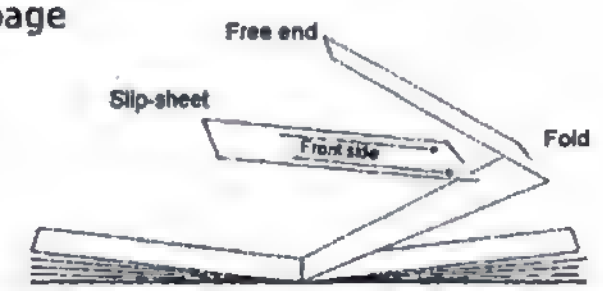

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Inverted Foldout slip-sheet

GbsSlipSheet-001

Foldout slip-sheet

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PC MAGAZINE

The Ultimate Upg

You've invested money and time into your PC. You thought it would last forever, but technological advances are shrinking your system's lifespan. Can you buy time with a replacement part, or should you get a new PC? We've compiled the following upgrade list to help make that choice. On the opposite page, we give advice on where to spend an extra $300 on a new PC, as well as tips on how to optimize your old PC's performance.

WHEN TO UPGRADE

Each component below is listed at its lowest acceptable level for a Microsoft Windows 95–equipped computer today (for example, a 486DX2/66 is the slowest processor that you should be using). If you find that your machine is behind this technological curve, you should consider investing in a new system.

PROCESSOR: 486DX2/66 A 66-MHz 486-class CPU—still very much in use in office PCs today—has just enough processing power to keep most Windows 95 applications going. Its days are numbered, however, so start planning for at least a Pentium/133-based PC. You can upgrade the processor in many systems, but remember that CPU upgrades don't address other possible system shortcomings, such as a slow graphics card or a slow hard disk.

MONITOR: 14-INCH, 0.31 DOT PITCH The graphical nature of Windows 95 makes a monitor of at least 14 inches (measured diagonally) mandatory. A smaller screen or a dot pitch of more than 0.31 mm guarantees eye strain. A 15- or 17-inch monitor with a dot pitch of 0.28 mm or less is truly what you need for Windows 95. Look for monitors which support the DDC1 or DDC2 standard, as these offer Plug and Play compatibility with Windows 95.

LOCAL-BUS SUPPORT: MANDATORY If your PC has nothing but ISA expansion slots in it, you're in luck: You now own an antique. Realistically, your PC must have some form of local-bus support—be it VL-Bus, PCI, or a proprietary design—to support Windows 95's graphics, deliver data at an acceptable rate, and handle full-motion video clips. As long as you can find local-bus graphics boards and disk controllers to work with your PC's local-bus design, you're okay for the time being. Your next PC must have PCI support to be viable for the future.

MEMORY: 16MB OF RAM 16MB is the minimum amount of memory you should have. Even Microsoft has stopped claiming that Windows 95 PCs run with 4MB. Performance improves as you add more RAM, and memory prices have come down significantly since the beginning of the year.

HARD DISK: 540MB Windows 95 applications are big. Don't expect even a 340MB hard disk to support you as you upgrade your operating system and applications from Windows 3.*x* to Windows 95. A 540MB hard disk is still limiting, but a disk compression utility (such as the one built into Windows 95) can buy you some time. Your next hard disk should be 1.2GB or larger.

VIDEO: 1MB DRAM A graphics subsystem based on a VL-Bus, PCI, or proprietary local bus is a must for Windows 95. If your PC lacks local-bus support, see the next item below.

CD-ROM DRIVE: DOUBLE-SPEED Single-speed CD-ROM drives are clearly obsolete, but you can still get away with using a double-speed unit. Since 6X drives are only marginally more expensive than 4X drives, a 6X drive is what you should aim for in your next PC.

MODEM: 9,600-BPS FAX AND DATA While 28.8-Kbps fax modems are the standard today, a 9,600-bps fax modem will still allow you to access most online services effectively. But 9,600 bps is a bit slow for any real surfing on the World Wide Web, unless you're willing to turn off the graphics support on your Web browser.

SOUND CARD: 8-BIT If all you need is audio, an old 8-bit sound card will give it to you, albeit with all the fidelity of AM radio. If you want the demons in your computer games to sound more menacing than mice with laryngitis, an upgrade to a 16-bit audio board will get you better sound. Wavetable-synthesis support is your next step if you want truer sound from your 16-bit card.

PRINTER: INK JET With ink jet printers starting at less than $300, there's no reason to use a dot matrix or daisy wheel printer today. A three-color ink jet printer with an option for switching to black-ink–only printing is as low as you should go when you shop for a new printer. For only about $100 more, you can purchase a four-color ink jet for true blacks, instead of greenish, process black.

1996 Buyers' Worksheet

Before you begin shopping for your perfect PC, take a few minutes to fill out this worksheet, so you'll know exactly what you want. Consult our recommendations below for a dream system, office PC, and home PC to help you decide.

PERFECT PCs: PC MAGAZINE'S RECOMMENDATIONS

FEATURE	THE DREAM SYSTEM	THE OFFICE PC	THE HOME PC
Processor	Pentium/200 or Pentium Pro/200	Pentium/133 or Pentium/166	Pentium/166 or Pentium/200
L2 cache	512K synchronous*, 256K integrated**	256K synchronous	256K synchronous
System memory	32MB–64MB EDO or SDRAM	16MB EDO	16MB EDO
Expansion bus	PCI/ISA with USB	PCI/ISA (USB optional)	PCI/ISA with USB
Hard disk	4GB Fast/Wide SCSI-2	1.2GB EIDE (minimum)	2GB EIDE (minimum)
CD-ROM drive	8X	4X (minimum)	6X
Sound card	32-bit with wavetable synthesis	16-bit	32-bit with wavetable synthesis
Speakers	Self-powered with subwoofer	2 piece or integrated on monitor	Self powered with subwoofer
Graphics card memory	4MB–8MB	2MB	2MB
Monitor size	21-inch	17-inch	15-inch (minimum)
Modem	ISDN	28.8/14.4-Kbps	28.8/14.4-Kbps
Network interface card	10/100-Mbps PCI Ethernet	10/100-Mbps PCI Ethernet	Optional
Floppy disk drive	3.5-inch, 1.44MB	3.5-inch, 1.44MB	3.5-inch, 1.44MB or LS-120
Tape backup	DAT	Optional	ZIP or DAT
Uninterruptible power supply	Standard	Optional	Recommended
High-speed serial and parallel ports	Standard	Recommended	Recommended
Infrared port	Standard	Optional	Optional
Keyboard and mouse	Standard	Standard	Standard (USB recommended)
Operating system	Windows 95*, Windows NT**, or OS/2*	Windows 95*, Windows NT**, or OS/2*	Windows 95
Software bundle	Standard	Optional	Standard
Warranty	3 years	3 years	1 year (minimum)
On-site service	3 years	1 year (minimum)	1 year (minimum)
24-hour, 7-day support	Standard	Standard	Recommended
Total price	$7,000–$8,500	$2,500	$3,500

*Pentium. **Pentium Pro

PERFECT PCs: YOUR THREE CANDIDATES

FEATURE	MODEL:	MODEL:	MODEL:
Processor			
L2 cache			
System memory			
Expansion bus			
Hard disk			
CD-ROM drive			
Sound card			
Speakers			
Graphics card memory			
Monitor size			
Modem			
Network interface card			
Floppy disk drive			
Tape backup			
Uninterruptible power supply			
High-speed serial and parallel ports			
Infrared port			
Keyboard and mouse			
Operating system			
Software bundle			
Warranty			
On-site service			
24-hour, 7-day support			
Total price (including tax and shipping)			

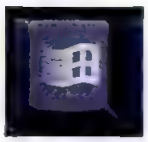
Gateway 2000

Portable PCs

them. None of their little mouths moved, but I heard a voice inside my head. Sounded just like your Uncle Larry. Seems word of the Gateway Solo has spread across the galaxy. The voice said for the best value in the computer industry on the latest technology, go to Gateway 2000. Now, I would consider that a pretty long trip to go shopping, but I can see how portable computers would be mighty important if you were an alien prairie dog.

nputing, places.

"Come on! They're in the car!" she called climbing in behind the wheel. "I'm showing them the sights. Bring your Gateway notebook — I've told them all about it!"



Gateway Solo notebooks are optimized for Microsoft® Windows® 95.

The alien prairie dogs sat quietly in a line across the car's back seat. In my head I heard my Uncle's voice

And we were off, into the night.

say hello. And we were off, into the night.

Models from the Gateway Solo multimedia line have a modular CD-ROM drive.

The next morning I woke up in the back seat alone. Mother and the aliens had gone. In my hand was a note. "Honey, look after Dad for me. Took your Gateway Solo S5-133XL notebook. Hope you don't mind! (Wonder if Gateway's 24-hour, seven-day-a-week technical support works on an intergalactic call?) I have a feeling my adventures are just beginning."

For more computing, more places — call Gateway 2000 today.

intel inside
pentium PROCESSOR

GATEWAY2000
"You've got a friend in the business."®

800-846-4206

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Foldout slip-sheet

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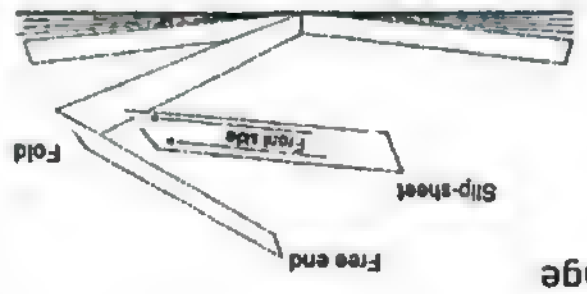

Inverted Foldout slip-sheet

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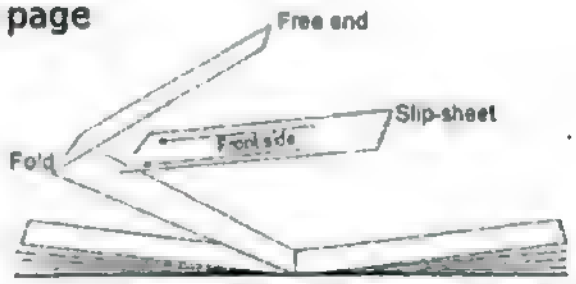

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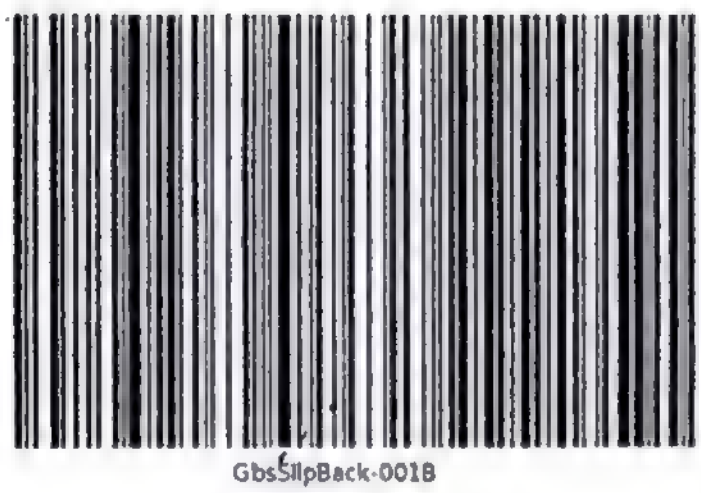

Back

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Copyrighted mater

Sleep. My kingdom for a good solid eight hours. But my mind was racing. One last trick. I grabbed my Gateway Solo™ S5-133XL multimedia notebook and headed off to bed. The combination of 310 thread count sheets and responding to e-mail should end this bout of insomnia. That's what I love about my trusty Gateway 2000® Solo notebook. Gives me the freedom to compute anywhere. Sporting a powerful 133MHz Intel Pentium® processor, active matrix SVGA color display, 40MB RAM, gigantic 1.2GB hard drive, and 4X CD-ROM drive, it's the best of both worlds — high-end desktop power that fits on my lap.

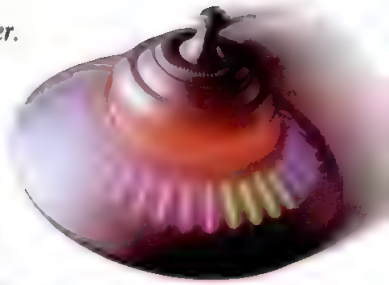
GATEWAY2000 SOLO

My eyelids felt like lead.

In no time at all my eyelids felt like lead. I reached out to embrace sleep like a long lost friend.

Then I heard it. Tires screeching and a car horn shattering the still night. Grabbing my robe I flew down the stairs.

It was mother.



Her red '57 came to a halt inches from the begonias. "DEARIE!

He just loves that portable to pieces.

They've finally come!" she yelled bounding towards me.

Mother had been on full alien alert for well over two decades. And by the look on her face the "they" could only mean intergalactic visitors. I braced myself.

"Dad had just fallen asleep in the recliner," she began, hardly able to contain herself. "His Solo S5-120XL notebook on his lap. He just loves that portable to pieces.

More co
more

"Anywho. I hear this ruckus outside. Sounded like the time your little brother tried to rake leaves using the vacuum. I poked my head out the back door and there it was!

"A real-live alien ship!" she exclaimed. "And me with no coffee made! The little buggers look just like prairie dogs, except for the antennae of course.

EZ Pad™ pointing device for easy cursor navigation.

"There were about 30 of

GATEWAY2000
S O L O

S5-100XL

- 10.4" Active Matrix SVGA Color Display
- Intel® 100MHz Pentium® Processor
- 8MB RAM (expandable to 40MB)
- 256K Pipelined Burst Cache
- 540MB Hard Drive
- Modular 4X CD-ROM Drive
- Modular 3.5" Diskette Drive
- Integrated 16-Bit Sound with Stereo Speakers
- 1MB Video RAM
- EZ Pad™ Pointing Device
- Lithium Ion Battery & AC Pack
- 86-Key MS Windows 95 Keyboard
- Parallel, Serial, Infrared, VGA & PS/2® Ports
- Built-In Mic, Headphone and Line-In Jacks and External Volume Control Dial
- 5.4 Lbs.*, 11.8" x 8.8" x 2.0"
- Microsoft® Windows® 95**
- MS Works 95
- Carrying Case

$2899

Business Lease††
$107/mo

S5-120XL

- 10.4" Active Matrix SVGA Color Display
- Intel 120MHz Pentium Processor
- 16MB RAM (expandable to 40MB)
- 256K Pipelined Burst Cache
- 810MB Hard Drive
- Modular 4X CD-ROM Drive
- Modular 3.5" Diskette Drive
- Integrated 16-Bit Sound with Stereo Speakers
- 1MB Video RAM
- EZ Pad Pointing Device
- Lithium Ion Battery & AC Pack
- 86-Key MS Windows 95 Keyboard
- Parallel, Serial, Infrared, VGA & PS/2 Ports
- Built-In Mic, Headphone and Line-In Jacks and External Volume Control Dial
- 5.4 Lbs.*, 11.8" x 8.8" x 2.0"
- Microsoft Windows 95**
- MS Office 95, Professional Edition†
- Carrying Case

$3699

Business Lease††
$136/mo

S5-100XL DELUXE

- 11.3" Active Matrix SVGA Color Display
- Intel 100MHz Pentium Processor
- 16MB RAM (expandable to 40MB)
- 256K Pipelined Burst Cache
- 1.2GB Hard Drive
- Modular 4X CD-ROM Drive
- Modular 3.5" Diskette Drive
- Integrated 16-Bit Sound with Stereo Speakers
- 1MB Video RAM
- EZ Pad Pointing Device
- Lithium Ion Battery & AC Pack
- 86-Key MS Windows 95 Keyboard
- Parallel, Serial, Infrared, VGA & PS/2 Ports
- Built-In Mic, Headphone and Line-In Jacks and External Volume Control Dial
- 5.4 Lbs.*, 11.8" x 8.8" x 2.0"
- Microsoft Windows 95**
- MS Office 95, Professional Edition†
- Carrying Case

$4099

Business Lease††
$151/mo

S5-133XL BEST BUY

- 11.3" Active Matrix SVGA Color Display
- Intel 133MHz Pentium Processor
- 40MB RAM
- 256K Pipelined Burst Cache
- 1.2GB Hard Drive
- Modular 4X CD-ROM Drive
- Modular 3.5" Diskette Drive
- Integrated 16-Bit Sound with Stereo Speakers
- 28.8 PCMCIA Fax/Modem
- 1MB Video RAM
- EZ Pad Pointing Device
- Lithium Ion Battery & AC Pack
- 86-Key MS Windows 95 Keyboard
- Parallel, Serial, Infrared, VGA & PS/2 Ports
- Built-In Mic, Headphone and Line-In Jacks and External Volume Control Dial
- 5.4 Lbs.*, 11.8" x 8.8" x 2.0"
- Microsoft Windows 95**
- MS Office 95, Professional Edition†
- Carrying Case

$5599

Business Lease††
$200/mo

**The Gateway Solo line starts at 5.4 lbs. Weight includes 8MB RAM, 810MB hard drive, lithium ion battery & option bay cover.*

***MS-DOS® 6.22 and MS Windows for Workgroups 3.11 available upon request.*

†MS Office 95, Professional Edition includes Word, Excel, PowerPoint® presentation graphics program, Schedule+, along with MS Access® database and Bookshelf® 95.

††Leasing arranged by independent leasing companies to qualified commercial customers. Lease payments based on 36-month term. Lease terms subject to change without notice or obligation.

PERIPHERAL OPTIONS

- 2GB Hard Drive (Upgrade from 1.2GB) **$300**
- Lithium Ion Battery **$200**
- PCMCIA Token Ring Adapter **$399**
- PCMCIA 3COM® Ethernet Twisted Pair Adapter **$129**
- PCMCIA 3COM Ethernet TP/ BNC Combo Adapter **$159**
- PCMCIA 28.8 Fax/Modem **$229**
- Infrared Desktop Module **$79**
- Solo Docking Bar **$150**
- 3-Year Limited Warranty **$100** *(For a free copy, call or write.)*
- Extended VIP Limited Warranty **$100**
- Call for additional memory and hard drive options.

SERVICE & WARRANTY

- Call for service and warranty options
- Portable-specific toll-free service and support
- One-year limited warranty standard. For a free copy, call or write.

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NO PAYMENTS
Ask about our "90 Days No Payment" Program!

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Toll free from Puerto Rico
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GATEWAY2000
"You've got a friend in the business."®

8 0 0 - 8 4 6 - 4 2 0 6

intel inside
pentium PROCESSOR

Designed for
Microsoft
Windows 95

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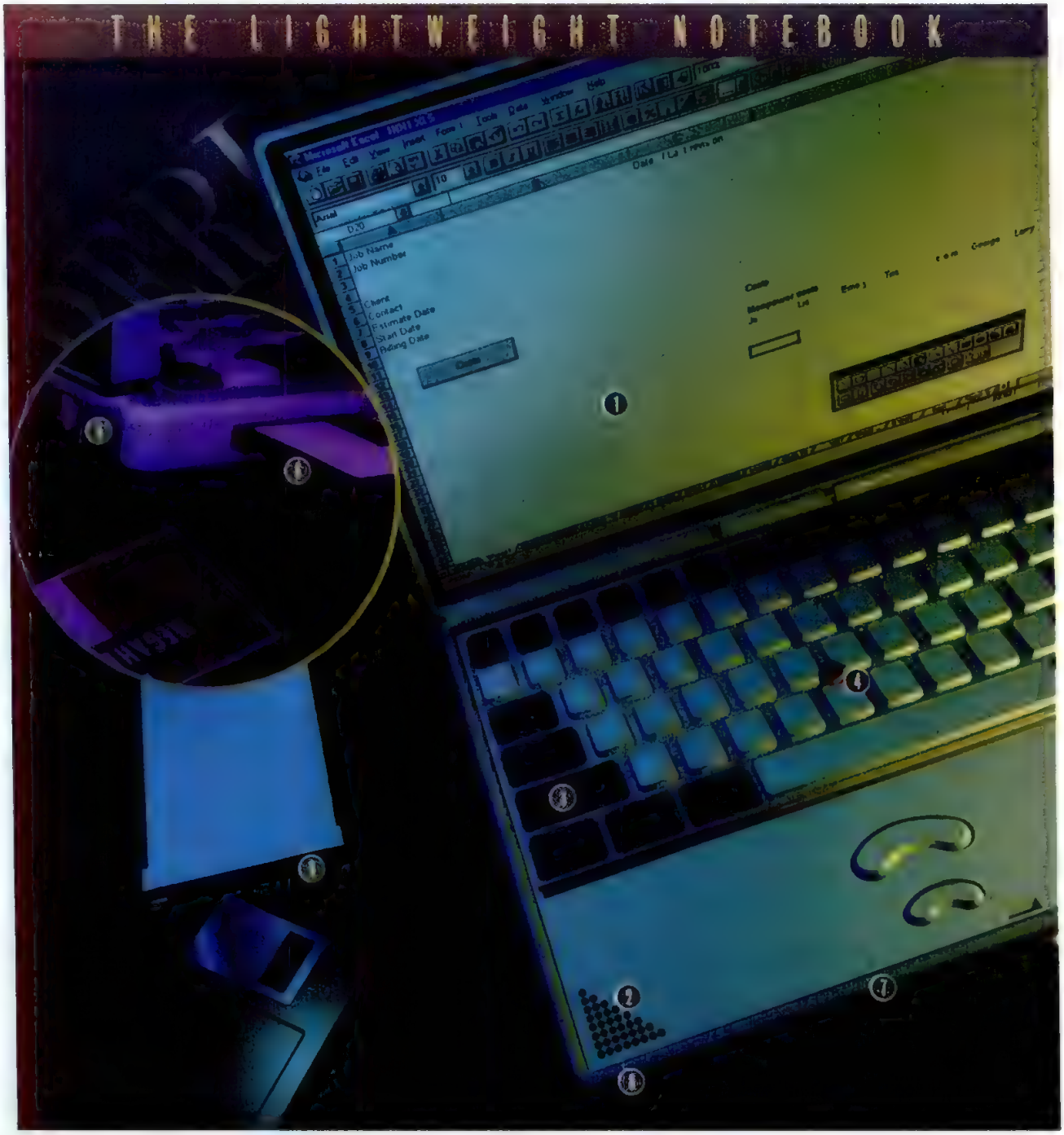

THE ROAD WARRIOR

Today's subnotebooks (some are championing "ultraportable" instead) aren't "sub" anything. Look for a machine with a Pentium/100 or faster CPU, a 1GB or larger hard disk, 16MB of RAM, and 256K of L2 cache—in a less-than-5-pound package. Price: $2,500 to $3,500.

1. **10.4-inch** or larger active-matrix SVGA display.
2. **Integrated speakers and microphone.** 16-bit wavetable audio support is a plus.
3. **Full-size** or slightly shrunken (18-mm) keyboard.
4. **Integrated pointing device.** Pointing sticks and trackballs are popular in this class.
5. **A built-in 28.8-Kbps fax modem** will save you the hassles associated with PC Card modems.
6. **Two stacked Type II PC Card slots,** which will accept a single Type III device.
7. **A lithium-ion battery pack** is an absolute must for maximum battery life.
8. **Infrared transceiver,** 115-Kbps IRDA-compliant or 4-Mbps Fast-IR.
9. **External 3.5-inch floppy disk drive:** The perfect component to leave at home to shave another pound off the total travel weight.

FILES ON DEMAND

The configuration illustrated here will support a department of 60 or more clients. A comprehensive server-management solution is also highly recommended. Price: $15,000 to $20,000.

1. **UPS:** Should support the server's power consumption for at least 20 minutes.
2. **DAT (4-mm) drive.** Capacity meets disk subsystem capacity.
3. **Quad-speed CD-ROM drive.**
4. **Lockable front panel.**
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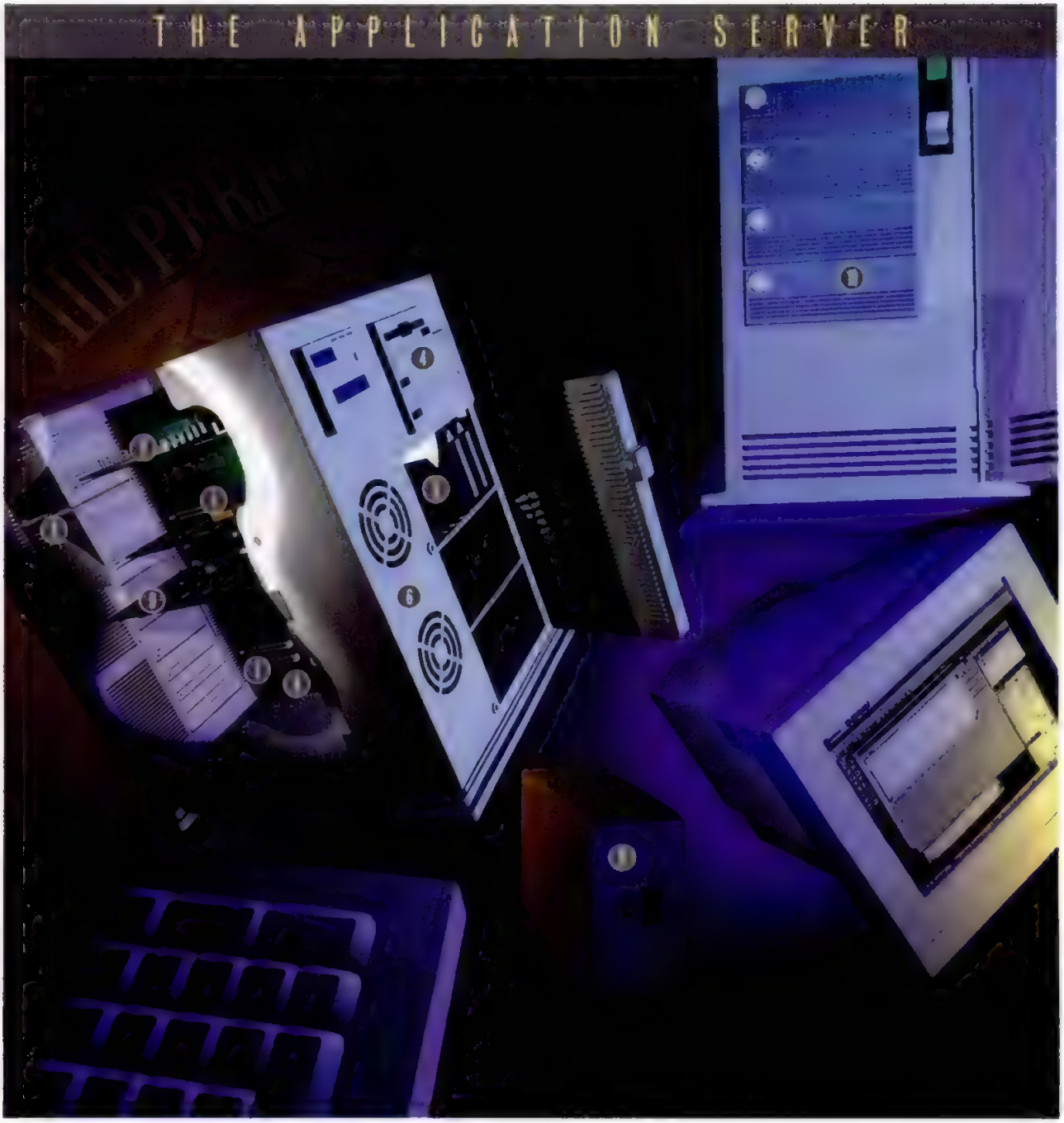

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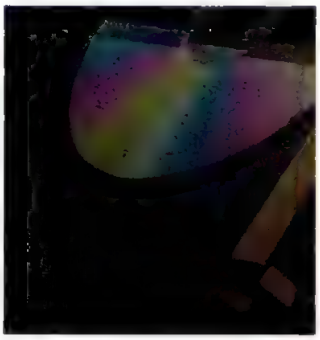
The Perfect Components

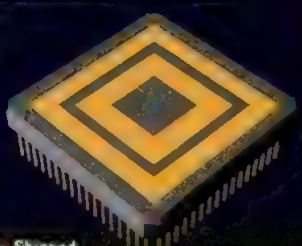


Now that you have a bird's-eye view of our Perfect PCs, it's time to delve deeper into the components that make up these systems. In this section, we examine virtually every major component that goes into a computer today, explaining the technologies behind the components and testing the competitors head-to-head to see which ones live up to the promises of their marketing sheets.

Our coverage starts with the basics: the perfect processor, memory, and motherboard. In the memory section, PC Labs tests the most popular types of both main memory and processor cache memory to see which combinations give you the best system performance for your dollar. We also examine the perfect peripheral bus, from Enhanced IDE and SCSI to up-and-coming technologies, including the Universal Serial Bus and IEEE 1394 (code-named *FireWire*).

Next, we look at the perfect graphics accelerator and monitor, as well as the perfect CD-ROM drive—with a speed shootout among ATAPI and SCSI 4X, 6X, and 8X devices. Then we move into the mass-storage arena for a discussion of hard disks, as well as a look at different types of removable media, including CD-R drives, magneto-optical devices, and tape-backup devices. This section concludes with the perfect speakers and sound cards, which will help you set up your perfect-sounding multimedia machine.

CPU TIME LINE



- Shipped
- Announced
- Announced but not shipped

March 1992
- 100-MHz MIPS R4000

September 1992
- 150-MHz Digital Alpha 21064

October 1992
- 50-MHz Sun MicroSPARC

February 1993
- 50-MHz Sun SuperSPARC

March 1993
- 60-, 66-MHz Pentium

June 1993
- 150-MHz MIPS R4400

July 1993
- 200-MHz Digital Alpha 21064

August 1993
- 60-MHz Sun SuperSPARC

October 1993
- 50-, 66-, 80-MHz IBM PowerPC
- 85-, 110-MHz Sun MicroSPARC II

March 1994
- 90-, 100-MHz Pentium
- 60-, 66-MHz NexGen Nx586
- 66-MHz Digital Alpha 21068
- 166-MHz Digital Alpha 21066
- 100-MHz MIPS R4600

June 1994
- 75-MHz MIPS R8000
- 133-MHz MIPS R4600
- 200-MHz MIPS R4400

July 1994
- 225-MHz Digital Alpha 21064A
- 275-MHz Digital Alpha 21064A

THE PERFECT Processor

By Richard Fisco • A processor is the heart of the PC. Without it, you have nothing but a collection of parts that add up to an expensive paperweight. The CPU you choose can give you the power to run games, compute spreadsheets, and run 3-D applications—even motion video—faster than ever before.

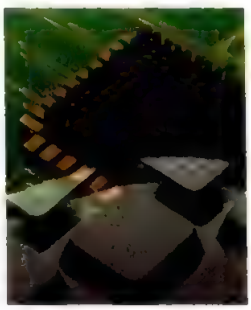
For many, today's top choice is a Pentium-class CPU. No 486-class CPU is powerful enough to warrant a new purchase, no matter how cheap it may be. The Pentium Pro is a good bet for the future: It gives optimum performance with 32-bit operating systems and applications, but with 16-bit OSs and applications, it performs roughly on a par with Pentiums. In this section we'll discuss the pros and cons of today's CPUs and take a peek at the future as well.

INTEL: REIGNING CHIP KING

The leading supplier of microprocessors today is Intel, by far. The vendor's sheer size, manufacturing capabilities, and engineering prowess make it the undisputed champ. Even with this lead, though, Intel does not sit still in the area of product development. New processors appear from Intel about every 18 months, and in between, the company keeps tweaking the performance of existing chips with die shrinks and faster clock speeds.

Intel's fifth-generation CPU, the Pentium, is currently the mass-market leader for desktop and notebook PCs. The Pentium gains its performance edge with features like superscalar design, an on-chip floating-point unit, and a 64-bit system bus. To enhance its position, Intel also manufactures core-logic chip sets and motherboards.

Intel's sixth-generation chip, the Pentium Pro, is its performance leader. This chip's architecture is very different from that of the Pentium: The Pentium Pro is *superpipelined* (its pipelines are deep and multistaged), and it uses what Intel calls *dynamic execution* (a speculative, out-of-order design) to enhance performance. The Pentium Pro contains the same amount of Level 1 (L1) cache as the Pentium—8K instruction and 8K data—but a feature unique to the Pentium Pro is the inclusion of Level 2 (L2) cache in the same package. The Pentium Pro comes with either 256K or 512K of four-way, set-associative L2 cache. Since the cache is on-chip, it runs at the CPU speed, and performance is much faster than with off-chip L2 cache.



The Pentium Pro's design allows it to perform at nearly twice the speed of a Pentium at the same MHz level when running 32-bit applications under a 32-bit OS. With 16-bit apps and OSs, however, the Pentium Pro performs only on a par with a Pentium of the same clock speed. This occurs because certain instructions will cause the Pentium Pro's pipeline to stall. Some compilers can deal with this situation, but with handwritten assembly code (as is found in portions of Windows 95), partial register stalls are more common. The result? The Pentium Pro performs at its best with a full 32-bit OS, such as Windows NT or OS/2 Warp, not Windows 95.

CYRIX: SERIOUS CONTENDER

Intel may rule in sales of PC processors, but there's a chink in its armor. Cyrix has developed its Pentium-pin-compatible 6x86 (formerly code-named M1) processor, denoting a comparison to sixth-generation chips like the Pentium Pro. According to our tests, Cyrix can claim the crown for Windows 95 performance, but it is not a serious challenger to the Pentium Pro.

In our recent review of the first Cyrix 6x86 PCs ("Beyond the Pentium," May 28, 1996), the 6x86 P166+ was the top-performing *x*86 CPU under Windows 95. But when we ran 32-bit apps under Windows NT and OS/2, the tables were turned: The 6x86 performed on a par with the Pentium on tests involving integer calculations, and the Pentium beat the 6x86 on tests with floating-point calculations.

The 6x86 takes a more straightforward

September 1994
- 70-, 75-, 84-, 93-MHz NexGen Nx586

October 1994
- 75-MHz Pentium
- 100-MHz IBM PowerPC 601

January 1995
- 85-MHz Sun SuperSPARC II
- 266-MHz Digital Alpha 21164

March 1995
- 120-MHz Pentium
- 200-MHz Sun UltraSPARC I
- 166-, 233-MHz Digital Alpha 21066A
- 300-MHz Digital Alpha 21164

April 1995
- 110-MHz IBM PowerPC 601

May 1995
- 90-MHz MIPS R8000

June 1995
- 100-, 120-, 133-MHz IBM PowerPC 604
- 133-MHz Pentium

July 1995
- 100-MHz Cyrix CX5x86
- 250-MHz MIPS R4400

October 1995
- 100-MHz Cyrix CX6x86 (P120+)
- 143-, 167-MHz Sun UltraSPARC I
- 150-MHz IBM PowerPC 604

November 1995
- 150-MHz Pentium Pro
- 120-MHz Cyrix CX5x86 (P90+)
- 133-MHz AMD5K86 (P75)

- 120-, 133-MHz NexGen Nx586 (P120 and P133)
- 120-MHz IBM PowerPC 604

December 1995
- 300-MHz Digital Alpha 21064A
- 333-MHz Digital Alpha 21164

January 1996
- 150-, 166-MHz Pentium

approach to operations than other processors. It doesn't convert code to RISC-like instructions; instead, the 6x86 operates on non-uniform-size *x*86 code (in "native" *x*86 mode) more efficiently than other CPUs do. The use of superpipelined architecture, register renaming, data dependency removal, branch prediction, and speculative execution gives the 6x86 its performance edge.

Indeed, the 6x86 runs at a slower clock speed than a corresponding Pentium: The Cyrix 6x86 runs at 133 MHz, but it's called the P166+. This naming convention comes as an answer to a dilemma that Cyrix, as well as rival AMD, faced: They both offer chips with slower clock speeds than the Pentium's yet with similar performance levels. Their achievements had made megahertz meaningless, but how could they convey this to the end user? AMD, Cyrix, IBM, and SGS-Thomson answered the question by joining forces to create the *P-Rating Specification.* This spec is meant to gauge the performance of their CPUs relative to that of the Pentium.

To generate the P-rating, the vendors use Ziff-Davis's Winstone 96 benchmark test program under Windows 95. They run Winstone 96 on identically configured PCs (except, of course, for the CPU) and compare scores. If a competitor's score is within 1.5 percent of the corresponding Pentium's score, then it earns a rating equivalent to that of the Pentium.

Since Cyrix does not own a fabrication plant, it relies on chip manufacturers with excess capacity. Currently, Cyrix contracts with IBM and SGS-Thomson to produce the 6x86. As part of the agreements, both companies have the right to sell 6x86 parts bearing the IBM or SGS logo.

AMD: PLAYING CATCH-UP

AMD is also bidding for a piece of the microprocessor pie. The vendor was early to announce its Pentium-equivalent chip (code-named the K5), but the chip's initial release was delayed, because its performance was not up to the levels AMD wanted. AMD found that some *x*86 instructions were used more frequently than had been thought and the K5 wasn't optimized to handle those—thus dragging down the chip's performance. This situation allowed Cyrix to get a jump on AMD.

Multimedia extensions to new CPUs will radically change the x86 architecture.

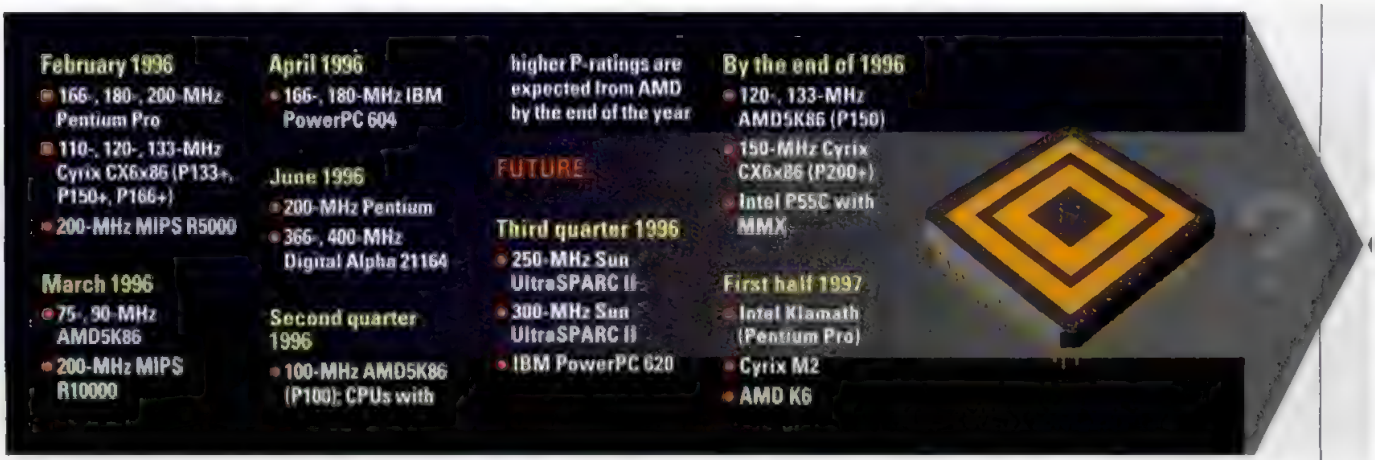
AMD has now released the K5, calling it the AMD5K86. The chip shares a design feature with the Pentium Pro: It converts *x*86 code to RISC-like operations, which AMD calls RISC ops (ROPs). Employing other features, including a superscalar design, out-of-order speculative execution, dynamic cache, line-oriented branch prediction, and a 16K instruction and an 8K data cache, the 5K86 looks like a viable challenger to the Pentium. For now, however, this is only speculation, as *PC Magazine* has yet to test a PC with a 5K86 CPU.

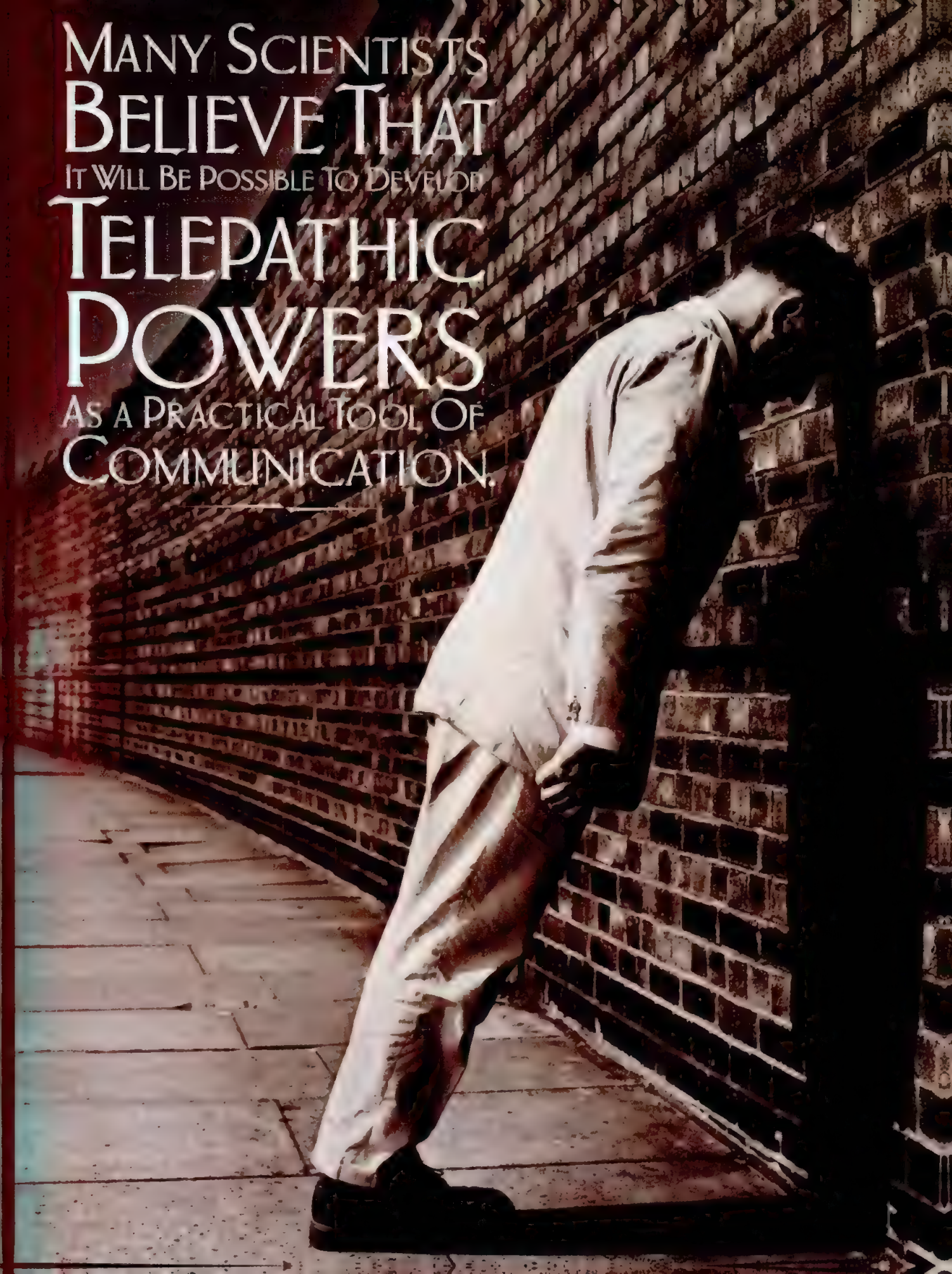
The 5K86's initial offerings will be at the 75-MHz and 90-MHz levels and will compare with the Pentium on a clock-for-clock basis; they will also be pin-compatible with the Pentium. By the third quarter of 1996, AMD will offer 5K86 chips that run at 100 MHz or faster, with performance enhancements in place to overcome the problems that had delayed the initial release. The P-ratings of these chips are expected to be above the rated clock speeds.

One more competitor, NexGen, would have appeared here, but it was recently bought by AMD, and production of NexGen's chips was discontinued. NexGen had the first true Pentium competitor in its Nx586, but it had too many handicaps to overcome: The Nx586 was not pin-compatible with the Pentium (so it required special motherboards and chip sets); it lacked an on-chip floating-point unit (FPU); and supporting PCI chip sets were late to market.

MULTIMEDIA ENHANCEMENTS

Forthcoming multimedia enhancements will radically change the *x*86 architecture. Intel has already introduced its multimedia extensions (MMX) to the *x*86 instruction set—the first major change to the instruction set since the 386. MMX will boost performance on many audio, video, and image-processing applications. Intel

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will include MMX on its next Pentium processor (code-named the P55C), with systems expected at year's end.

To enhance the P55C, Intel will include a larger L1 cache (16K instruction, 16K data). The chip will also be a 2.5-volt part, as opposed to the current Pentium's 3.3 volts. The lower voltage and higher performance will make the P55C ideal for notebook PCs as well as for desktops.

Certainly AMD and Cyrix are not going to stand still. AMD has recently signed a five-year cross-licensing deal with Intel to acquire the rights to MMX technology (as well as to Intel's instruction set). Look for AMD to implement MMX in its next-generation K6 CPU. Cyrix will also wait until it introduces its next-generation chip, the M2, to implement multimedia extensions (which should be Intel MMX-compatible).

CHIPS OF THE FUTURE

Intel has two variants in the wings to supplement the Pentium Pro: Klamath and Deschutes (these are code names). Klamath is rumored to have a larger L1 cache than the Pentium Pro and no internal L2 cache. Like all new Intel CPUs from now on, it will incorporate MMX technology. Moving the cache off-chip will make the part cheaper to manufacture and give vendors more flexibility in system/cache design. Deschutes will likely be a 0.25-micron version of Klamath and have a lower supply voltage, making it a good candidate for portables.

Next up for Cyrix is the M2, which will probably be called 7x86. Based on the M1's core, the M2 will include higher clock rates and multimedia extensions. It appears Cyrix will start sampling in late 1996 and begin production in early 1997.

Clearly, AMD purchased NexGen for two reasons: for the design of the NexGen 686 (which will become AMD's K6) and for NexGen's experienced microprocessor design team. Performance enhancements to the K6—including improved out-of-order execution, an integrated low-latency FPU, and Intel-compatible multimedia extensions—could make this chip the first serious challenger to the Pentium Pro. AMD is scheduled to begin production in early 1997.

HOW TO DECIDE

Deciding which processor is right for you means asking two questions: What do you want to do with your PC today, and where do you want to go with it over the next two to five years? Intel's Pentium is the market leader, but if you run only Windows 95, the Cyrix 6x86 can give you a small performance edge—for now. Of course, this scenario changes under Windows NT; here the Pentium Pro is the performance leader. With the planned addition of MMX technology, the Pentium Pro's performance is only going to improve. For now, the only choice for a top-performing, workstation-class, *x*86-based PC with Windows NT is Intel.

Without tested parts, it's hard to tell, but 1997 is shaping up as a shoot-out among Intel's P55C and Klamath, AMD's K6, and Cyrix's M2. Keep an eye on the competition, but rest assured that Intel will be king of the mountain for the foreseeable future.

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PC MAGAZINE

THE PERFECT Memory

By Margaret Piemonte • Memory: We know we have it, and we know we need it. We've heard that the more a PC has, the better its performance will be. This section will explore the different types of main memory (called DRAM, or dynamic random access memory) and processor cache memory (called Level 2 or L2 cache) available for a PC today. By varying the amounts and types of DRAM and L2 cache in your system, you can get different performance returns.

As CPU speeds increase, so does the need for faster system components. Traditionally, the memory bus runs much slower than the CPU. But with Intel's newest PCI chip sets, the 430HX and 430VX, faster memory technologies can be implemented, closing the gap between the speed of the memory bus and the speed of the CPU.

FAST PAGE MODE: A DYING BREED

Fast-page-mode (or FPM) DRAM used to be standard issue on mainstream PCs. But the market has recently seen a surge in the availability of newer and faster memory types, which have all but succeeded in displacing FPM DRAM as the memory of choice. In fact, in our last roundup of 101 Pentium-class PCs ("Pentium Classic: Still the One," June 25, 1996), only three PCs used FPM DRAM.

FPM-memory read accesses begin with the activation of a row in the DRAM array, then move on to the activation of the first column of a memory address location that contains the data that you want. Each piece of information needs to be validated, then the data needs to be latched back to the system. Once the correct piece of information is found, the column deactivates and gets ready for the next cycle. This introduces a wait state, because nothing is happening while the column is deactivating. (The CPU must wait for the memory to complete the cycle). The data output buffer is turned off until either the next cycle begins or the next piece of information is requested. In fast page mode, the next column in the row activates in anticipation of the fact that the next piece of data you need is in the memory location adjacent to the previous piece. This activation of the next column works well only with sequential reads from memory in a given row.

Ideally, a read from 50-nanosecond FPM memory can achieve a burst cycle timing as fast as 6-3-3-3 (6 clocks for the first data element, followed by 3 clocks each for the next three data elements). The first phase includes the overhead created by activating the row and column. Once they have been activated, the memory can transfer the data in as few as three clock cycles per piece of data.

EDO DRAM

Extended data out (EDO, sometimes called hyper-page-mode) DRAM and *Burst EDO* (BEDO) DRAM are two memory technologies based on the fundamentals of page-mode memory. EDO was introduced into mainstream PCs about a year ago and has since become the main memory of choice for many system vendors. BEDO is relatively new and has not yet caught the market's attention to the extent that EDO has.

EDO works much like FPM DRAM: A row of memory is activated, and then the column is activated. But when the piece of information is found, instead of deactivating the column and turning off the output buffer (which is what FPM DRAM does), EDO memory keeps the output data buffer on until the next column access or next read cycle begins. By keeping the buffer on, EDO eliminates wait states, and burst transfers happen more quickly.

EDO also enjoys a faster ideal burst read cycle timing than FPM DRAM: 6-2-

SYSTEM PERFORMANCE

Memory and L2 Cache

	No L2 cache	256K asynchronous L2 cache	256K pipelined-burst L2 cache	512K pipelined-burst L2 cache
ZD WINSTONE 32				
8MB fast-page-mode DRAM	30	35	37	38
8MB EDO DRAM	35	35	39	39
16MB fast-page-mode DRAM	57	70	88	91
16MB EDO DRAM	67	73	91	94
ZD CPUMARK32				
8MB fast-page-mode DRAM	167	220	271	303
8MB EDO DRAM	212	232	303	326
16MB fast-page-mode DRAM	168	224	288	323
16MB EDO DRAM	212	236	312	331
	BETTER▶	BETTER▶	BETTER▶	BETTER▶

We tested on a Dell OptiPlex 5166 (Pentium/166) PC with a 2GB hard disk and a Number Nine Imagine 128 graphics card.

2-2 versus FPM's 6-3-3-3. This ultimately saves three clock cycles in a burst of four data elements from DRAM on a 66-MHz bus. EDO is easy to implement, and with virtually no price difference between fast page mode and EDO, there is no reason not to choose EDO.

BURST EDO DRAM

BEDO DRAM improves cycle times over FPM much more than EDO does. Since most PC applications access memory in four-cycle bursts to fill cache memory (system memory will burst its data into L2 cache, or to the CPU in the absence of L2 cache), once the first address is known, the next three can quickly be provided by the DRAM. The essential enhancement that BEDO offers is the addition of an address counter on the chip to keep track of the next addresses.

BEDO also adds a pipelined stage that allows the page-access cycle to be divided into two components. For a memory read operation, the first component accesses the data from the memory array to the output stage (second latch), while the second component drives the data bus from this latch at the appropriate logic level. Since the data is already in the output buffer, faster access time is achieved. BEDO can achieve a maximum burst timing of 5-1-1-1 (with 52-ns BEDO and a 66-MHz bus), saving an additional three clocks over optimally designed EDO memory.

SYNCHRONOUS DRAM

Intel's 430VX chip set supports a new type of memory technology called *synchronous* DRAM (SDRAM). A key feature of SDRAM is its ability to synchronize all operations with the processor clock signal. This makes the implementation of control interfaces easier, and it makes column (but not row) access time quicker. SDRAM includes an on-chip burst counter that can be used to increment column addresses for very fast burst accesses, similar to BEDO's. This means that SDRAM allows new memory accesses to be initiated before the preceding access has been completed.

SDRAM can achieve a burst timing of 5-1-1-1 with a 66-MHz bus in a well-designed and well-tuned PC. The SDRAM's burst length and latency are fully programmable via an on-chip mode register.

PROCESSOR CACHE

When we read about cache, we are usually reading about Level 2 cache, or external cache. L2 cache has been the domain of a very fast and expensive memory type called *SRAM* (static RAM) that holds data frequently used by the CPU so that

EDO has displaced FPM DRAM as the memory of choice in most PCs today.

the CPU doesn't have to rely solely on slower DRAM. Since fast types of DRAM are available, some vendors offer cacheless PCs to hit a lower price range. Through our testing, however, we've found that the performance levels achieved by cacheless PCs can't match the performance of a PC with L2 cache.

The simplest form of SRAM uses an *asynchronous* design, in which the CPU sends an address to the cache and the cache looks up the address, then returns the data. An extra cycle is required at the beginning of each access for the tag lookup. Thus, asynchronous cache's response time can be as fast as 3-2-2-2 on a 66-MHz bus, although 4-2-2-2 is much more common.

Synchronous cache buffers incoming addresses to spread the address-lookup routine over two or more clock cycles. SRAM stores the requested address in a register during the first clock cycle. During the second, it retrieves the data and delivers it. Since the address is stored in the register, synchronous SRAM can then receive the next data address internally while the CPU is reading the data from the previous request. Synchronous SRAM can then "burst" subsequent data elements without receiving and decoding additional addresses from the chip set. Response time can be reduced—optimally—to a 2-1-1-1 timing on a 66-MHz bus.

Another type of synchronous SRAM is called *pipelined burst*. Pipelining essentially adds an output stage that buffers data reads from the memory locations so that subsequent memory reads are accessed quickly, without the latency incurred by traveling all the way into the memory array to get the next data element. Pipelining works most effectively with sequential access patterns, such as cache linefills.

PERFORMANCE RESULTS

Standardizing our test-bed was the key to consistent results. We used a Pentium/166 PC, from Dell Computer Corp., with an Intel 430FX chip set, a Seagate 2GB Fast ATA-2 hard disk, and a Number Nine Imagine 128 graphics card. To ensure a consistent set of test criteria, all of the memory used for our tests was supplied by a single company, Kingston Technology Corp. (800-337-8410; *http://www.kingston.com*).

The most significant change in performance in all the testing scenarios was the increase in Winstone 32 scores when a machine's EDO DRAM was raised from 8MB to 16MB. Conversely, there was very little or no change in performance in $CPUmark_{32}$ scores in the same scenario, because CPUmark stresses the CPU, L2 cache, and memory speeds.

The numbers also show little performance gain in Winstone 32 scores when comparing fast-page-mode DRAM to EDO with any amount or type of cache. When there is no L2 cache, however, EDO shows its biggest performance gain over FPM: 15 percent with 8MB and 18 percent with 16MB.

For a machine with 16MB of EDO DRAM and no L2 cache, a big performance boost was achieved by adding 256K of pipelined-burst L2 cache: 47 percent on $CPUmark_{32}$, and 36 percent on Winstone 96. In general, adding cache or changing from asynchronous to synchronous pipelined-burst cache will result in a bigger increase in CPU/memory performance (as measured by $CPUmark_{32}$) than in overall system performance (as measured in Winstone 32).

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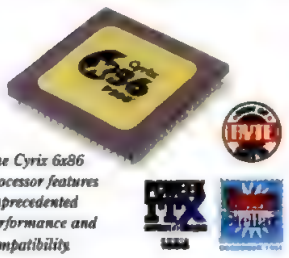

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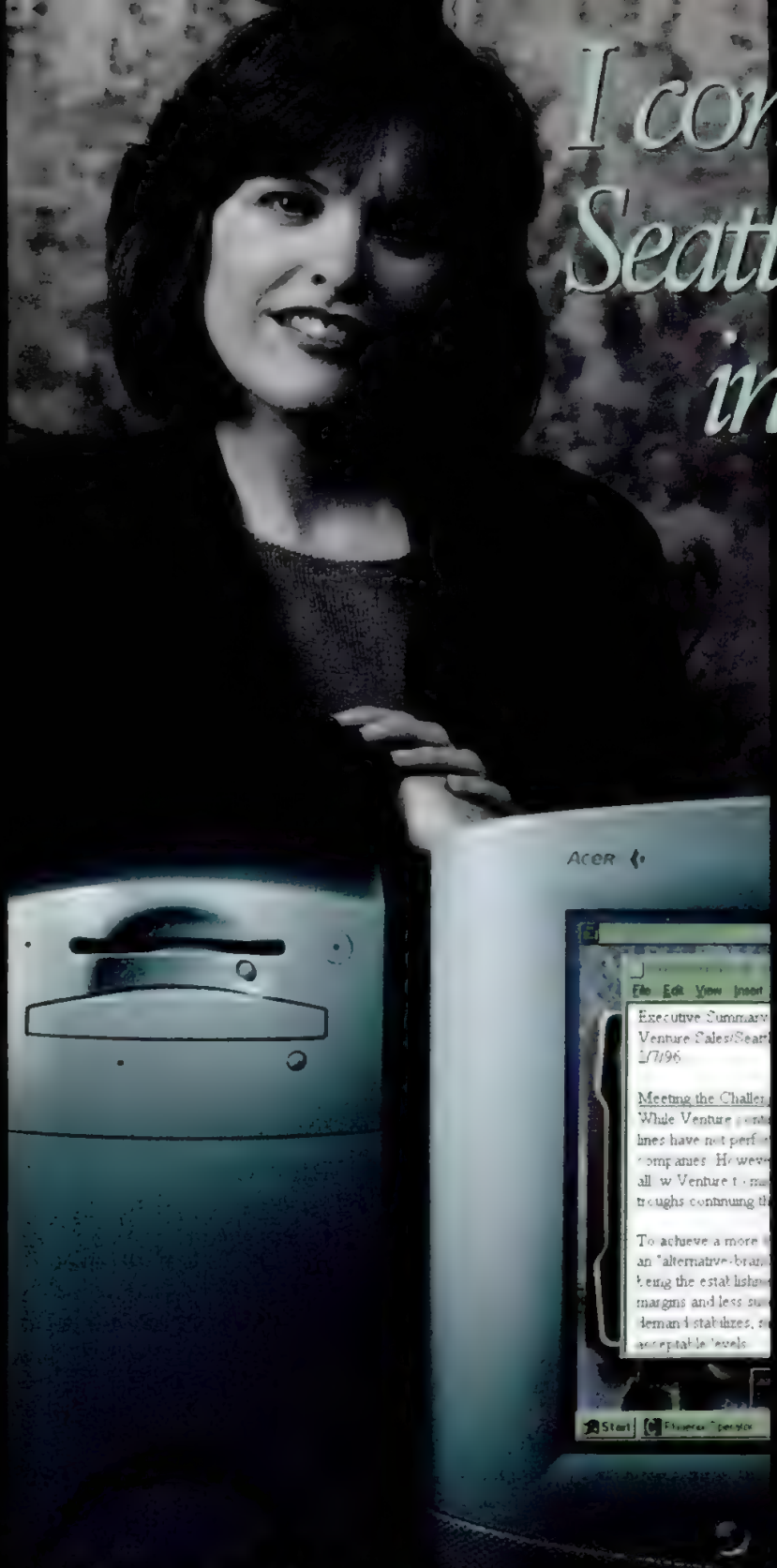

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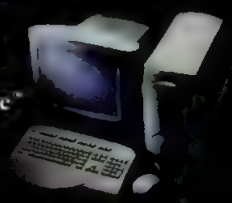

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THE PERFECT Motherboard

By Richard Fisco • A motherboard is more than just a place to put a processor. Engineers must consider which components will be used and where they will be placed, as well as how connections should be made. Trade-offs must be considered. In other words, no single "perfect" motherboard exists.

In this section, we'll explain the most common technologies to give you an overall picture of what's necessary to formulate the perfect motherboard and to point out key things to keep in mind when purchasing a new PC. We'll focus here on Pentium-class motherboards, chip sets, bus speeds, and BIOSes. (See "The Motherboard" on the right, which illustrates how the new ATX motherboard design should help with layout problems.) Memory, cache, buses, and microprocessors are covered in separate sections of this story.

TWO DESIGNS

The ATX motherboard specification developed by Intel should eventually displace the long-used Baby-AT design. ATX's more efficient use of space and cheaper four-layer design provide a win-win situation for system vendors. ATX and Baby-AT boards are approximately the same size, but the ATX board is rotated 90 degrees within the PC's case, allowing easier access to internal components. The downside: ATX's four-layer design likely won't support bus speeds above 66 MHz.

1. **Memory slots:** Usually blocked by power supply on Baby-AT boards. ATX boards give clear access.
2. **Processor socket:** Often blocks expansion slots on Baby-AT boards. Moved up and out of the way on ATX boards.
3. **PCI and ISA expansion slots:** Positioned opposite CPU in Baby-AT design; some full-length cards might be unusable. Repositioning of the CPU socket in ATX design allows for use of all expansion cards, regardless of size.

CHIP SETS

If the CPU is the heart of a PC, then the chip set is the pacemaker. Chip sets control the memory I/O, the bus I/O, and, in many cases, the integrated IDE hard disk controllers. They also handle interrupt requests (IRQs) and direct memory accesses (DMAs).

Many chip sets are available, but Intel-manufactured chip sets are by far the most popular. The most commonly used Intel chip set, the 430FX (formerly known as the Triton), is soon to be replaced by the new and improved 430HX and 430VX chip sets (formerly the Triton II). The HX chip set is marketed for business PCs, while the VX chip set is meant for home and small-business PCs. Each offers a 64-bit memory path, concurrent PCI, and the 82371SB PCI I/O IDE Xcelerator. The 82371SB supports the Universal Serial Bus (USB), as well as PIO (programmed input/output) and bus-mastering IDE, and it is PCI 2.1–compliant.

The HX chip set also supports up to 512MB of main memory, dual processors,

and ECC memory. The VX chip set differs from the HX in that it supports up to only 128MB of main memory and also supports synchronous DRAM (SDRAM).

VIA's VT82C580VP Apollo-VP chip set for Pentium PCs has specifications similar to and in some cases exceeding those of Intel's 430HX chip set. The Apollo chip set, which is PCI 2.1–compliant, supports up to 512MB of memory, Unified Memory Architecture (UMA), concurrent PCI, L2 cache burst timing rates of 3-1-1-1, USB, and PIO and bus-mastering IDE. It also supports burst EDO (BEDO) and up to 2MB of L2 cache, as well as the Cyrix 6x86 CPU's linear burst mode.

Pentium-class chip sets are also available from OPTi (the OPTi Viper) and VLSI (the VLSI 500 series), although we've seen very few systems with either chip set in our mainstream PC roundups.

CONCURRENT PCI

The implementation of concurrent PCI in Intel core-logic chip sets permits more efficient operation of CPU, PCI, and ISA transactions for faster and smoother multimedia performance. Concurrent PCI implements four mechanisms to improve performance:

- *Multi-transaction timer (MTT).* This allows bus-mastering PCI cards to hold the PCI bus and perform short data bursts without having to re-arbitrate for the bus. That should help video performance.
- *Passive release.* By allowing interleaved access to the bus by CPU and PCI masters, the PC can continue transactions even when an ISA transaction owns the bus. Passive release should allow audio cards to use fewer system resources when a video clip is running.
- *PCI delayed transaction.* When a PCI-to-ISA transaction is held in the chip set, the bus masters are then free to use the PCI bus, and the ISA transaction is completed later. This allows the PCI and ISA buses to be used more efficiently and should yield smoother video playback.
- *Enhanced write performance.* The 430HX and VX chip sets' write performance is better than that of their predecessors because of the use of deeper buffers, write merging, and faster retire to DRAM. Because of the larger buffers, write cycles will have less of an impact on system performance. Write merging collects byte, word, and Dword cycles and combines them into a single write to DRAM.

SYSTEM BIOSes

The system BIOS (basic input/output system) is the piece of code typically residing on the programmable read-only memory (PROM) chip that all PCs need to operate. The BIOS runs a power-on self-test (POST) when you first turn on the PC, and it controls keystroke interpretation and port communication. Although there are many different BIOS vendors, differences among their products are few.

Look for a BIOS that supports Plug and Play (PnP) and power management. PnP is desirable, though not required, if you plan to use Windows 95. Without a PnP BIOS, your system is not fully PnP-compliant, and features such as power management and add-in card auto-detect may not work. If your company buys computers with Energy Star certification, the BIOS must have power management support. Your BIOS should support both system and monitor suspend and sleep modes.

The adjustability of performance settings, such as DRAM read/write timings, varies with the BIOS. Usually, the motherboard or system vendor will have set the timings for optimal performance. So for the most part, it is best to stick with those settings unless you are absolutely certain that faster timings will improve your PC's performance without causing problems.

BUSES

Motherboards have many buses: the memory bus, cache bus, ISA bus, and PCI bus. Although today's Pentium-class CPUs run at clock speeds of 75 to 200 MHz, the memory and cache are limited to 50, 60, or 66 MHz. The memory subsystem's running speed is called the *motherboard speed*, and the processor is clock-multiplied to run from 1.5 to 3 times as fast.

The disparity between CPU and memory subsystem speeds creates a bottleneck, especially at high CPU speeds. To help alleviate the problem, the motherboard speed must be increased to 75 MHz and beyond. It's not an easy task: At 75 MHz, electromagnetic interference (EMI) becomes a significant problem. Cyrix has stated that it is working on a 75-MHz motherboard with a third party, but this design has yet to be seen.

The difference between a 66-MHz and a 60-MHz bus may seem slight, but the speed delta trickles down. The PCI bus divides down using the motherboard clock, as shown in the chart. So though it may appear that a 120-MHz PC should be only slightly slower than a 133-MHz unit, in reality, the combination of slower CPU, memory subsystem, and PCI bus makes a Pentium/120 barely faster than a Pentium/100.

The *Universal Serial Bus* (USB) is a new bus designed to provide a single interface to connect mice, joysticks, keyboards, and telecommunications devices. USB's powered hub operates at 12 megabits per second (for devices such as printers that need their own power supplies), while a secondary, low-speed channel runs at 1.5 Mbps (for mice and keyboards).

USB allows you to daisy-chain up to 127 devices, similar to the way the Macintosh is set up today. But don't look for the serial, parallel, and game port connectors to go away all that soon. Literally millions of mice, joysticks, printers, and modems in use rely on those connectors.

Bus Speeds by Processor

Processor speed (MHz)	Memory and cache bus speed (MHz)	Processor multiplier	PCI bus speed (MHz)
75	50	1.5	25
90	60	1.5	30
100	66	1.5	33
120	60	2	30
133	66	2	33
150	60	2.5	30
166	66	2.5	33
200	66	3	33

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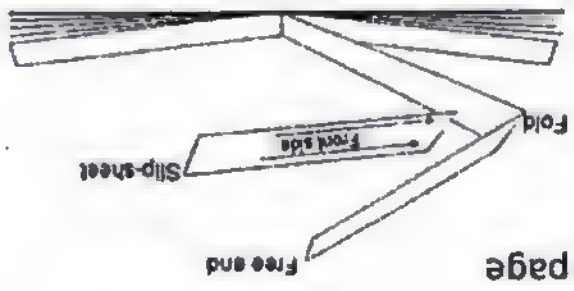

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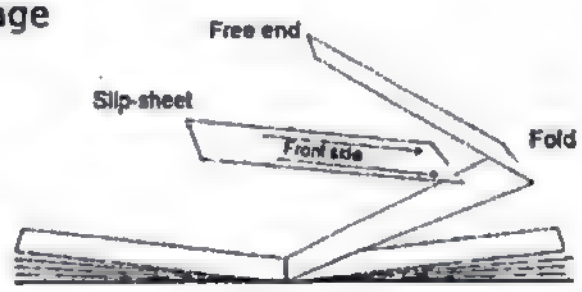

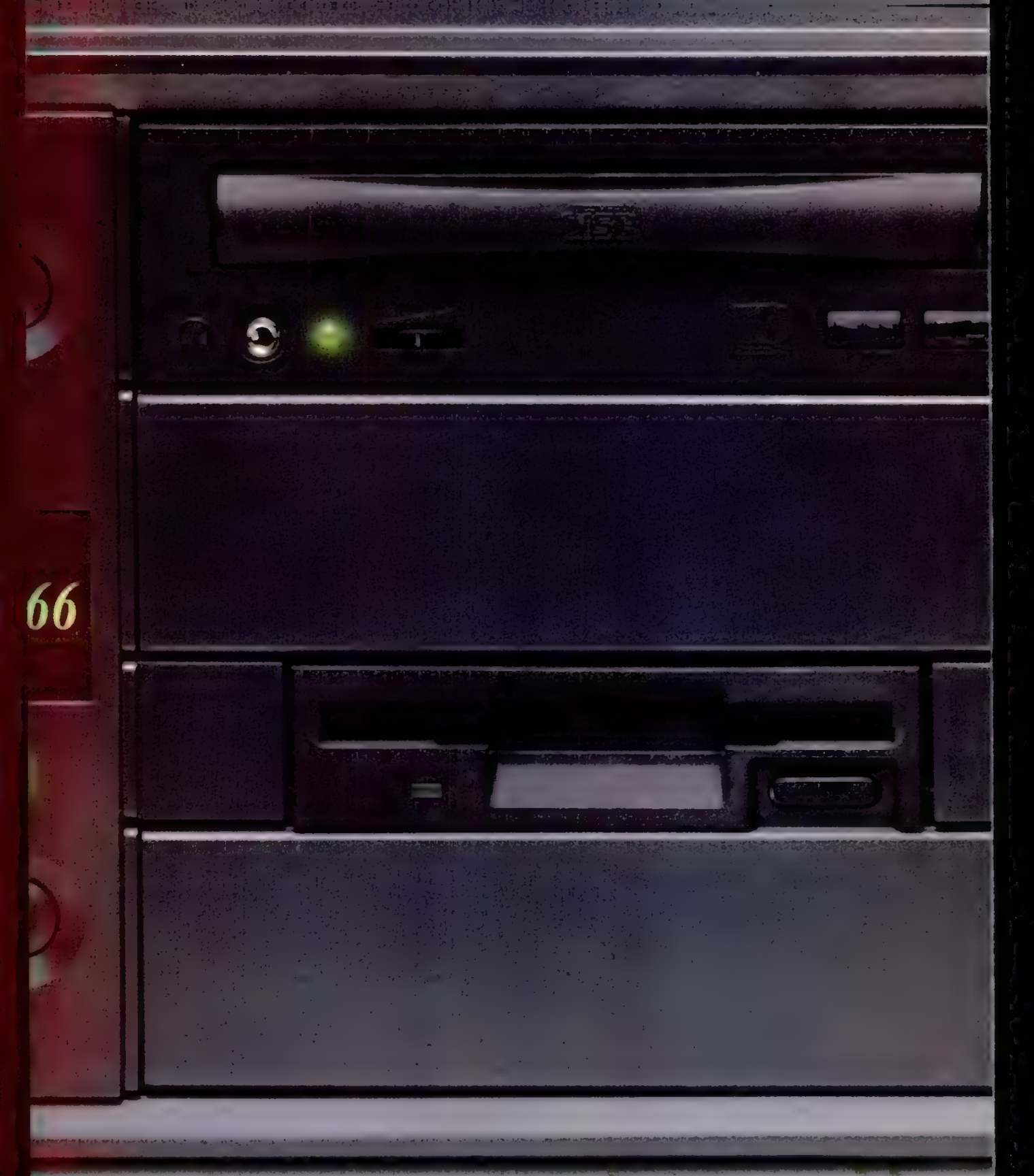

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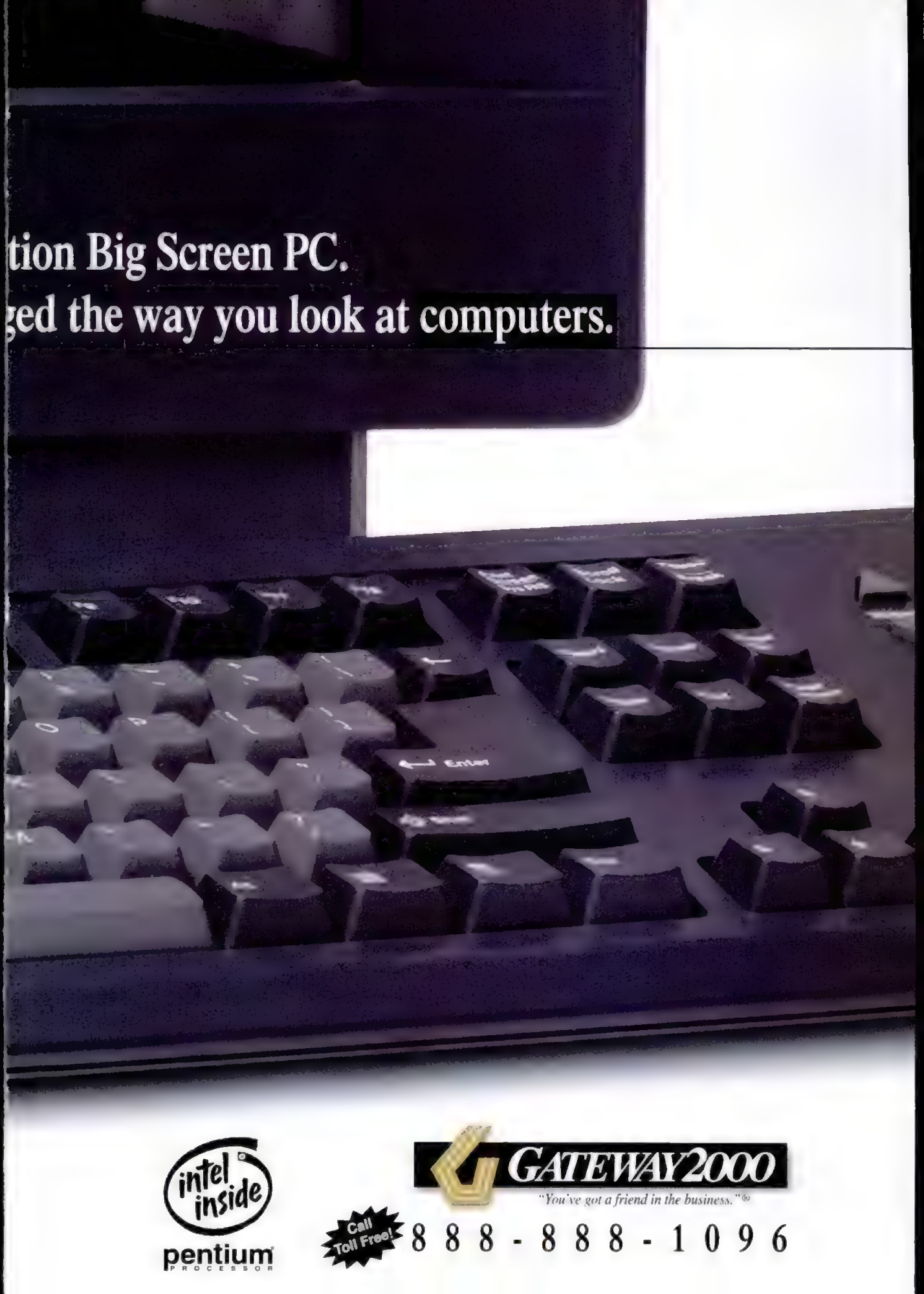
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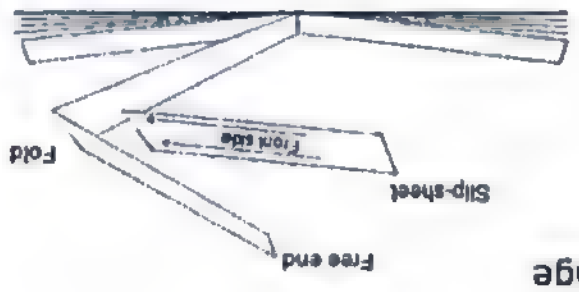

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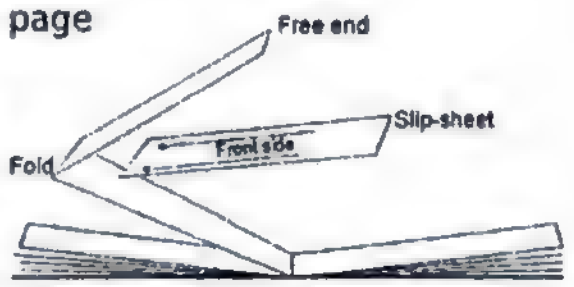

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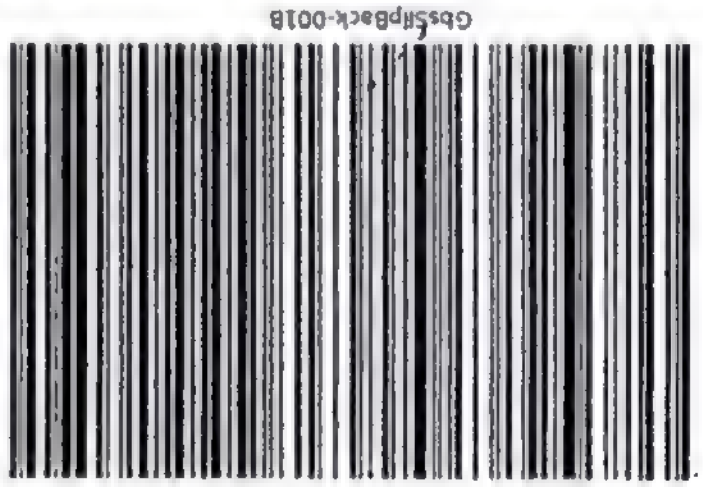

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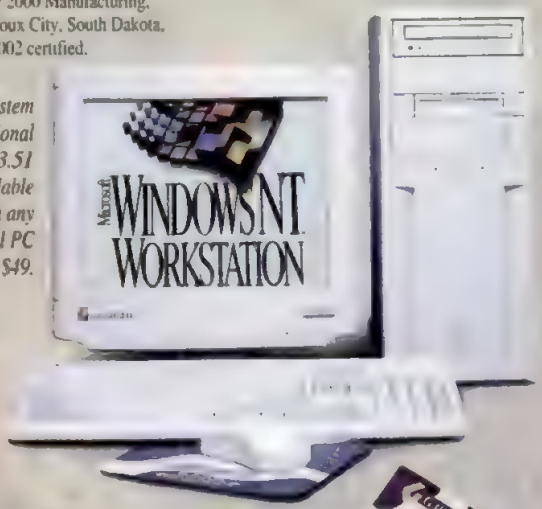

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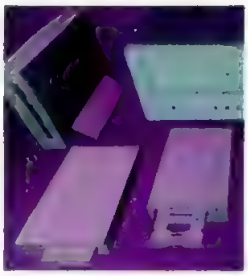
THE PERFECT Peripheral Bus

By James Karney • Selecting the right peripheral bus is a key element in designing the Perfect PC. This communications channel between a computer and its components plays a major role in how well a computer performs—and what it costs.

The simple bus for storage device is *ATA/EIDE* (AT Attachment/Enhanced Integrated Drive Electronics). It can run up to four devices at a respectable speed, and, since the late 1980s, most users have found it adequate for everyday computer needs. EIDE lets us add two hard disks, CD-ROM drives, and tape backup units with little fuss. Almost every new motherboard comes with two IDE interfaces built in, so the cost is almost nonexistent.

Like the old VGA cards, EIDE devices let the computer's CPU do most of the work. But over the years improvements have been made, raising the theoretical upper throughput performance limit from the original 3.3 MBps (megabytes per second) to 16.7 MBps, though we've reached only about half of that in actual use. That sounds great, but EIDE is a drain on the CPU and must use kludgey methods to handle large hard disks or demanding peripherals.



When it comes to theoretical speed and the number of devices supported, *SCSI* (Small Computer Systems Interface) is the king of the hill. Most devices available today are built to the SCSI-2 specification. *Fast SCSI* uses an 8-bit data path and a transfer rate of 10 MBps. *Fast/Wide SCSI-2* delivers 20 MBps on a 16-bit bus. The latest flavor, *Ultra Wide SCSI-3*, has an upper performance limit of 40 MBps. Like modern Windows display adapters, SCSI host adapters improve performance by taking over tasks from the CPU. Most can do more than one job at a time, and they improve throughput by ordering the way events are handled.

Using current-generation business applications in a real-world scenario, it is hard to see any remarkable performance advantage of SCSI over EIDE. Older 16-bit operating systems could only do one thing at a time. And while OS/2, Windows 95, and Windows NT are true multitasking, multithreaded environments, most apps don't yet take full advantage. So for most users, there is no clear advantage to SCSI; EIDE is perfectly adequate and cheaper. SCSI is preferable for users with many devices connected to their PCs, and it holds the potential—not yet proved, however—that it could provide better performance with 32-bit operating systems and applications.

SCSI does come out on top in the number and scope of devices it can connect. A single card can connect up to seven devices per channel, with up to three channels. Virtually all CD-R drives, scanners, and RAID arrays work only with SCSI interfaces. If you need more speed, more hard disk space, or plan to connect several devices, SCSI is the way to go. Most adapters will add about $100 to $300 to a system's cost.

Later this year the equation will start to change as two new peripheral bus technologies enter the marketplace. While the transition may take several years, the days of traditional EIDE and current SCSI technology are numbered. The *Universal Serial Bus* (USB) is a 12-Mbps (megabit-per-second) standard for connecting equipment like keyboards, monitors, input devices, and cameras (as many as 64 devices) to a PC. It will probably be too slow for good hard disk performance and hence may be coupled with advanced EIDE on low-end machines.

On the high end, *IEEE 1394* (sometimes referred to by Apple's trademark name, *FireWire)* is a high-speed serial SCSI standard that is getting a lot of attention. It has all the advantages of the current SCSI interface and excellent throughput: It will allow transfer rates from 100 to 400 Mbps, and some designers are forecasting that when optimized, it could run up to 1.6 Gbps. The first devices to use 1394 are digital video cameras and the like, where throughput is important.

If you plan on buying a new low-cost system this year with little more than a hard disk and a CD-ROM attached,

Current status

INTERNAL I/O BUSES

ISA
Since 1984, ISA has been the ubiquitous internal interface. Its 8-MHz speed and 3-MBps bandwidth make it suitable for mice and other low-speed devices.

EISA
With its 33-MBps transfer rate and 8.33-MHz bandwidth, EISA was used for high-end SCSI adapters and graphics cards but has fallen out of favor, except on a few servers.

VL-Bus
This 133-MBps burst 33-MHz bus was designed primarily for early high-performance Windows graphics adapters and storage devices.

PCI
This 133-MBps, 33-MHz bandwidth design, tuned for fast CPUs, was the successor to the VL-Bus and EISA. It incorporates the best of both and then some. It's the best solution today for high-speed storage, graphics adapters, and network cards.

EXTERNAL I/O BUSES

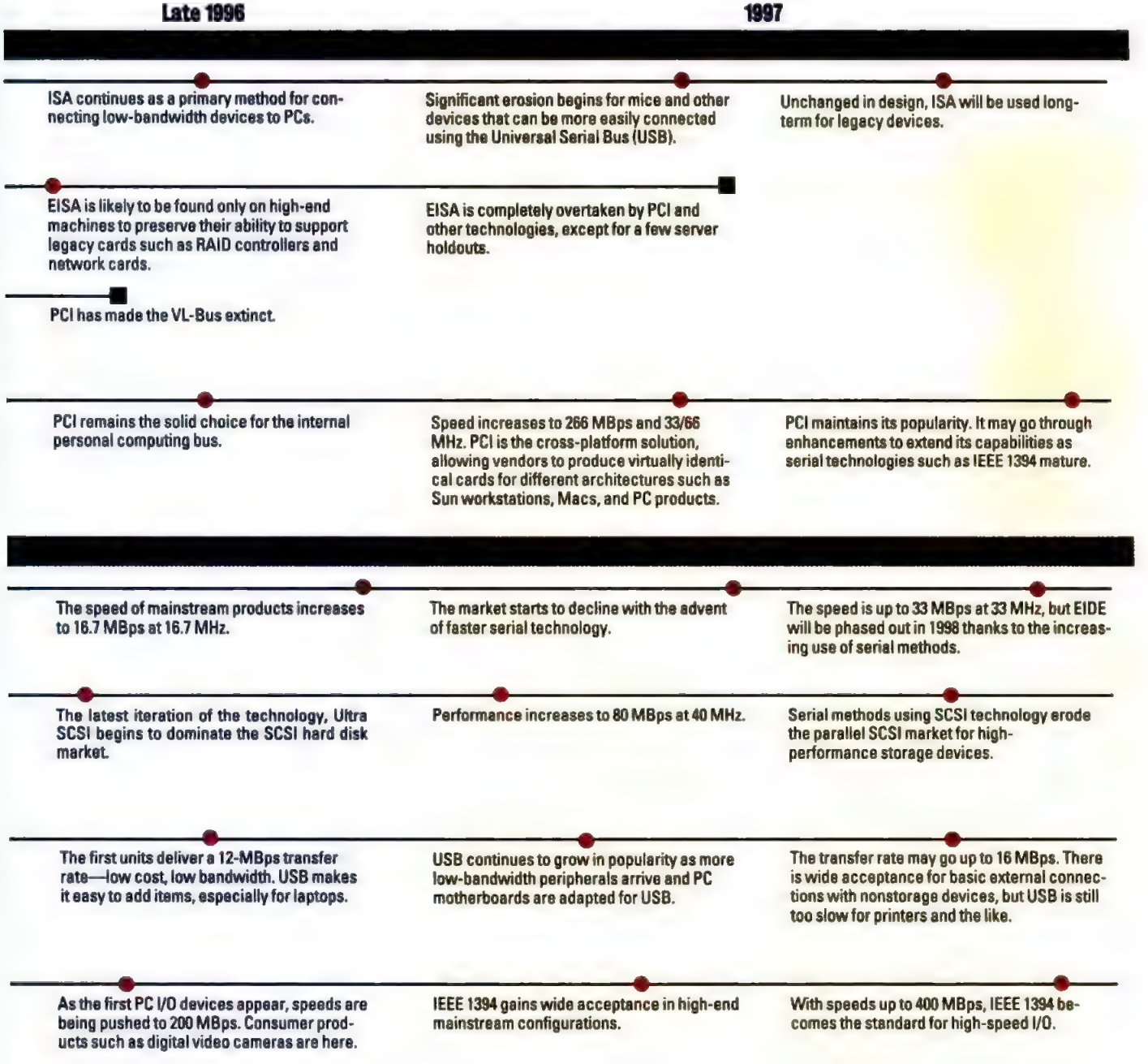
EIDE
The least expensive way to hook up hard disks, CD-ROM drives, and tape units to a PC is EIDE. It boosts performance over older IDE, giving 13.3 MBps at 13.3 MHz (theoretically).

SCSI
The preferred way to connect the widest range and number of devices, both external and internal, SCSI allows up to seven devices per channel, at up to 40 MBps at 20 MHz. It is the choice for servers, RAID installations, and high-performance storage devices.

USB (Universal Serial Bus)
USB is the up-and-comer for attaching monitors, input devices, page scanners, and other devices to a PC. USB-enabled PCs have appeared, but drivers and peripherals won't arrive until the end of 1996. A variation may allow low-cost hard disk connections.

IEEE 1394 (FireWire)
A SCSI serial technology still under development, this high-speed interface can handle live and recorded video I/O. With its inexpensive design and 100-MBps bandwidth, it will soon be used for hard disks, scanners, printers, and digital video devices.

Extinction and Evolution



EIDE has the cost advantage. More complex systems call for SCSI's ability to connect and manage more devices.

ON THE INSIDE

The dominant internal bus in PCs today—and for the foreseeable future—is *PCI* (Peripheral Component Interconnect). With its 133-MBps maximum throughput and Plug and Play compatibility, PCI has proved ideal for high-performance devices such as hard disks, graphics accelerators, and network cards.

Since its introduction in late 1993, PCI has steadily taken the reins from the competing high-performance technology, *VL-Bus*—which should be all but extinct by the end of this year. Another competing architecture, *EISA* (Enhanced ISA), will also fall by the wayside as PCI continues to improve.

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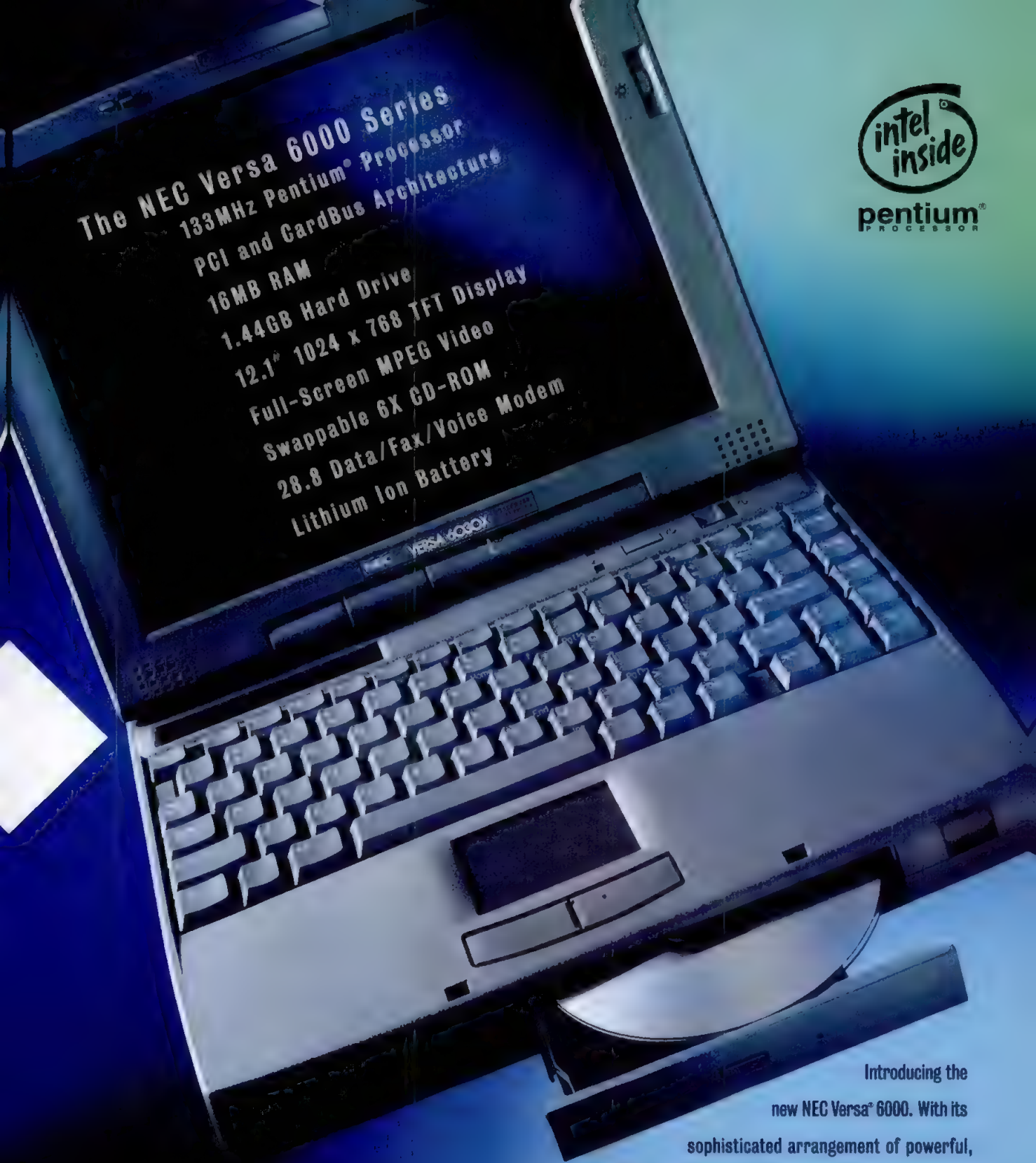

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CIRCLE 157 ON READER SERVICE CARD

THE PERFECT

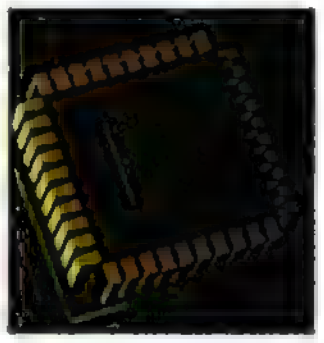
Graphics Accelerator

By Jeff Mace • Choosing the perfect graphics accelerator for the type of work you do can increase the overall performance of your system. These internal peripherals come in many flavors, so choosing the right one will require a little homework.

Each of today's graphics adapters includes the same integral parts. The *graphics controller*, for example, accelerates the GDI (graphics device interface) calls that your application generates as you work. Otherwise, GDI calls would have to be processed by your CPU and the Windows 95 DIB (Device Independent Bitmap) software accelerator, or the Windows NT GDI, or the OS/2 Presentation Device Driver. The board's *driver*, which provides the interface to the operating system, hands these calls to the graphics controller, which transforms the binary fonts, lines, pictures, fill colors, and whatever else needs to be presented to the screen into *pixels*, or picture elements.

The controller then sends the pixel information to the card's on-board RAM, the *frame buffer*. The new screen image is laid out and stored there according to the *x, y* grid that resembles the 2-D resolution of the screen. Next it is accessed, many times a second, by the *RAMDAC*, which converts the computer-generated digital pixels to the RGB (red-green-blue) analog signal that the monitor requires.

RAM is expensive, so you should calculate the amount of RAM you need based on the *resolution* (screen-image size) and *color depth* (number of colors) you choose to work in. A simple formula does this. Multiply the horizontal resolution by the vertical resolution, then multiply that answer by 1 for 8-bit color, by 2 for 16-bit color (65,000 colors), or by 3 for 24-bit color (16.7 million colors). For example, to work at 640-by-480 resolution with 256 colors (an 8-bit color depth), you would need 308K of memory on the board. To work at a 24-bit color depth, you would need three times the memory, or approximately 1MB, since you need a little extra space for off-screen memory tasks such as caching recently used bitmaps or fonts.



The most popular business resolutions today are 800-by-600 (SVGA) or even 1,024-by-768 for those with a 17-inch monitor. A little math quickly tells us that the perfect graphics board would need at least 2MB of RAM for the frame buffer to deliver 16-bit color at 1,024-by-768. If you want to run at 24-bit color or if you plan to move to a higher resolution down the road, you're best off looking for a board that lets you upgrade memory beyond 2MB later on. Graphics professionals who work with image-editing packages at even higher resolutions—up to 1,600 by 1,280 pixels—probably need a board with 6MB of RAM or more.

The perfect graphics board would need at least 2MB of RAM to deliver 16-bit color at 1,024-by-768.

POTENTIAL BOTTLENECKS

The bus connection provides the data entry point to the graphics board. Your purchase is restricted to the type of bus supplied on your PC's motherboard. While many graphics boards come in ISA, VL, and PCI bus formats, all the newer, faster products come only in PCI. With PCI, graphics controllers can use such features as bus mastering and Plug and Play support.

The width of the data path used by the graphics controller can introduce the next bottleneck. Most controllers today can accept 64 bits of data per clock cycle, or 32 bits per cycle when only 1MB of memory is present on the board. Once the data is on board and processed by the graphics controller, it needs to make the rounds to the frame buffer, then RAMDAC. Anything less than high-speed transfers here can bind up the process. Several memory designs and new graphics processors with memory controllers designed to work with these new memory types widen bandwidth and increase overall throughput.

MEMORY 202

Inexpensive entry-level boards use standard *DRAM* (dynamic RAM) or the newer EDO (extended data out) DRAM, which improves throughput by allowing the next memory cycle to be initiated before the previous cycle begins to finish, the same as your PC. But DRAM's single-port read/write port will always have trouble keeping up when color depths are higher than 8 bits per pixel. At higher color depths, DRAM is limited in its ability to act as a frame buffer, receive writes by the graphics controller, and simultaneously be read by the RAMDAC for refreshing the screen.

Since users will want to set their graphics board's screen refresh rate to at least 75 or 80 Hz to obtain a crisp, flicker-free display, *VRAM* (video RAM) memory designs offer a second read-only port dedicated to serving the RAMDAC. The similar *WRAM* (Window RAM) aids 24-bit performance through its support for aligned BitBlts. Other such memory designs are available, and newer ones seem to be coming out all the time. For instance, *SGRAM* (synchronous graphics RAM) has a block write capability similar to that of VRAM, which allows you to perform accelerated area fills and accelerated text painting, and there are new types of DRAM, such as *SDRAM* (synchronous DRAM) . The newest advanced memory type is Rambus, which enables very high on-board data transfers through a simple 32-pin interface to the memory controller.

MORE ADVANCED FUNCTIONALITY

Chances are you'll be working with video in some form if you have a CD drive, so the perfect graphics board should handle video. In its simplest form, processing motion video means processing a succession

of bitmap data at 15 to 30 frames per second (which makes the moving video appear real). This is a daunting task even for a graphics board with a dual-ported memory design. Look for a board that offers motion video acceleration and scaling, preferably with video-acceleration functions rolled into the controller.

3-D processing is the newest challenge for mainstream graphics boards. Like video processing, it will be rolled into many of the new boards. A 3-D processor will be responsible for applying the shading, or "skin" onto the wireframe geometry that represents the 3-D image. The mainstream boards won't rival the $2,000 cards aimed at CAD and animation pros, but they should prove fine for games and business apps with 3-D features.

Finally, look for a board that delivers creature comforts, such as rock-solid Windows 95, OS/2, or Windows NT drivers, and added features that let you easily set the refresh rate and switch resolutions.

RESOLUTION AND REFRESH RATE

For rock-solid images on the 17-inch display, make sure your graphics card can deliver 1,024-by-768 resolution at a refresh rate of at least 80 Hz. The card must also have dedicated drivers and utilities for the operating system you use, with features such as on-the-fly resolution switching. Price: $300.

1. **2MB RAM.** The average business user needs 2MB of EDO DRAM. A graphics workstation requires 4MB to 8MB of VRAM or WRAM.
2. **PCI bus, data path.** The newest, fastest cards provide PCI connectivity for better performance. Also, look for a card with a 64-bit data path.
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THE PERFECT Monitor

By Jamie M. Bsales • The monitor is the most-used part of your PC system, the part you interface with every moment you work at your machine. But too many people skimp when it comes to the display, either settling for the budget 14-inch monitor that came with their system or trading up to only a 15-inch unit. Home PC users who use their machines only a few hours a week may indeed want to stay with a more affordable—and less space-hungry—14- or 15-inch display. But business users who spend all day on their PCs will find the larger display worth the investment: The right monitor can make you more productive; the wrong one can cause headaches, fatigue, and eyestrain.

STOP SCROLLING AROUND

If you're buying today, the perfect monitor to purchase is a 17-inch unit (the size of the tube, measured diagonally). Note that the ads and packaging for monitors may say "17-inch class," followed by a figure—about 15.5 inches—that denotes the actual viewable area. Computer CRTs do not produce a picture edge-to-edge, so a 17-inch tube yields a smaller live area. Prices have been trending downward steadily for years, and an excellent 17-inch display can be had for about $750.

The increase in screen real estate means that you can set your monitor for a higher *resolution*—the size of the screen image, measured in pixels—and have more application windows accessible at once or see more of a large spreadsheet. You wouldn't want to run at a resolution above 800-by-600 on a typical 15-inch monitor, for example; the fonts and icons would appear too small. But a 17-inch monitor will let you work comfortably at 800-by-600, and most users will find 1,024-by-768 quite acceptable.

Next, make sure the monitor you choose supports a high *vertical refresh rate* at the resolution you intend to work in. Refresh rate is the number of times per second the screen image is redrawn. If a monitor runs at a low refresh rate (below 70 Hz), you will be able to see the screen flickering. This can be uncomfortable at least and at worst could lead to headaches and eyestrain. VESA (the Video Electronics Standards Association) recommends a refresh rate of 75 Hz or better, and that may soon increase to 80 Hz. So to ensure that the monitor is easy on your eyes, look for a refresh rate of at least 80 Hz at 1,024-by-768 resolution.

TUBE TYPES

Your next decision point is what type CRT you prefer. *Shadow mask* tubes, which have been around since the birth of

SIZE AND REFRESH RATE

The optimal monitor for a business user is a 17-inch unit that delivers 1,024-by-768 resolution at a refresh rate of at least 80 Hz. This will let you have multiple windows (or a large spreadsheet) viewable at once and ensure there is no noticeable flicker that could cause eyestrain.

Price: $750.

1. **Mask pitch.** A mask pitch of 0.28mm or less should mean a sharp image.
2. **On-screen controls.** An intuitive interface that lets you change a range of image attributes is a must. Extra controls that give instant access to brightness and contrast are a plus.
3. **Universal Serial Bus.** Debuting at the end of 1996, a USB-equipped PC and monitor will let you easily connect compatible peripherals.
4. **Tube type.** Most users will be happy with a shadow mask or slot mask tube; graphics pros might want to try an aperture grill monitor.

television, use a mask with small holes to deliver each red, green, and blue pindot of light. These masks vary in *dot pitch*, the space between two dots of the same color, measured in millimeters. Generally, the smaller the dot pitch, the sharper the screen image. We recommend a shadow mask CRT with a pitch of 0.28mm or less.

About ten years ago Sony introduced the Trinitron tube—an *aperture grille* design—for PC monitors. This type of CRT, now also manufactured by Mitsubishi under the DiamondTron brand name, has a mask with a vertical stripe pattern; its mask pitch is generally 0.25 to 0.30mm, though it is difficult to correlate this figure directly with the measurements given for traditional shadow mask designs. Aperture grille tubes are generally brighter, flatter, crisper (and more expensive) than traditional CRTs, but they might prove better for detailed work such as image editing and DTP. Note, however, that hairline damping wires, used to support the mask, are visible if you look for them; some users might find this distracting.

Some monitor makers—most notably NEC—recently have tried to bridge the gap between the two types, offering so-called *slot mask* designs that combine attributes of aperture grille and traditional shadow mask designs. These tubes use an elongated mask opening instead of dots, and they don't need damping wires.

IMPORTANT DETAILS

Finally, the perfect monitor offers extras that make working with it a little easier. It should offer an intuitive on-screen utility that lets you change image attributes beyond simply brightness and contrast. A better monitor will let you correct for *pincushioning* and *barreling* (where straight lines tend to bow on-screen), as well as easily set the *color temperature* (how warm or cool the colors look). Another nice touch is a color management utility such as Colorific, which lets you match the colors you see on-screen to those produced by your color printer.

The perfect monitor also delivers compliance with the Display Data Channel specification (the newest being DDC2B), which enables two-way communication between the monitor and a DDC-compliant graphics adapter in your PC. DDC lets the monitor and graphics card determine the resolutions and refresh rates each is capable of and then configure itself optimally. By the end of the year we should start seeing monitors that offer a USB (Universal Serial Bus) interface. If your PC is so equipped, you will be able to use your monitor as a connecting point for a host of peripherals (including your keyboard and mouse), which is more convenient than having to plug and unplug devices from the back of your PC.

More and more monitors are coming equipped with built-in speakers, which can be an elegant solution to desktop clutter. If you use your PC sound capabilities predominantly for business audio—such as videoconferencing or telephony—then a speaker-equipped monitor is right for you. If you tend to play music or games, the sound quality of the vast majority of monitor speakers will disappoint.

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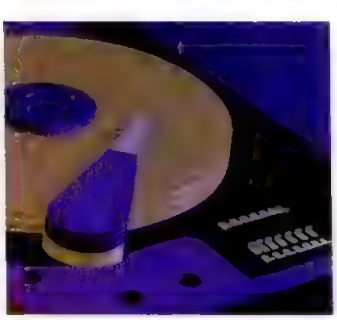
CIRCLE 037 ON READER SERVICE CARD

THE PERFECT Hard Disk

By John Bryan • So you're in the market for a hard disk? Microsoft Windows 95 and its associated applications, Internet access and the graphical nature of many of the files there, and the simple fact that we are using our computers for more and more things dictates that most of us are in the market for a new drive, whether we realize it or not. After all, disk drives are like closet space: You can never have enough.

There have been a number of developments in this field lately, and new head technology, faster rotational velocities, and upgraded read-channel abilities are all contributing to a better product. The most important change for most buyers, though, has been price: Entry-level desktop system drives of 1 to 2 gigabytes are priced from about 20 cents to 25 cents per megabyte, depending on the interface and performance characteristics. These figures indicate that over the past five years the industry has managed an increase in capacity and corresponding drop in price of at least an order of magnitude.

Most new PC systems are shipping with drives of 1.2GB to 1.6GB in capacity, and just about every drive manufacturer is shipping drives in the 2GB to 8GB range for the OEM and retail channels. If you're looking for the perfect hard disk that has room to grow in the next 6 to 12 months, we recommend a 2.1GB drive, which should cost about $360 list.



Many PC buyers may be tempted to opt for an even higher-capacity drive, such as a 4GB unit, to ensure that they have enough capacity for the life of their PC. If you're buying the drive bundled with a new system configured at the factory, this might be a good choice. Users looking to upgrade an existing system—especially a 486 or earlier—should think again: The PC BIOS has some significant limitations with respect to hard disk usage, and these limitations can result in lost capacity, inefficient use of available space, or system lock-up upon installation.

PCs using the Windows operating system store data on their hard disks in a format called FAT, or File Allocation Table. (Windows NT and OS/2 can also use FAT format, but they also have their own more efficient formats, NTFS and HPFS, respectively.) The File Allocation Table uses a series of 16-bit pointers to keep track of what sectors of the disk are free, belong to a file, or are unusable for some other reason. The largest partition that the DOS FAT structure can see is 2.1GB (2,146,959,360 bytes). Hence, drives larger than this must be partitioned into smaller logical drives using DOS FDISK or a similar utility.

Trouble is, you must install the drive before you can create partitions, and most older BIOSes—drive makers estimate 90 percent of those in 486 and earlier machines—won't allow you to install such a drive. The BIOS will either recognize only a portion of the large disk (up to 2.1GB, if you're lucky) or lock up the system altogether. If your system has a flash, or user-programmable, BIOS, your PC vendor can probably supply a BIOS program version that will enable the use of larger than 2.1GB disks. Otherwise you will need a secondary program, generally available from either your hard disk vendor or a disk-support application vendor such as Storage Dimensions (800-765-7895) or Ontrack (800-752-1333). The Windows 95 fix for this dilemma, FAT32, will begin appearing in preinstalled versions of the OS this summer; no plans to make it available to current users as an upgrade have been announced.

The second consideration after capacity is drive performance, largely determined by the rotational rate of the disk platters. Better disks for desktop PCs spin at 5,400 rpm (revolutions per minute). More cost-sensitive buyers can opt for a 4,500-rpm drive, which will deliver more than adequate performance.

A number of new developments—new head technology, faster rotational velocities, and upgraded read-channel abilities—are all contributing to a better product.

The *average seek time* is the time the drive takes to position the read head over the desired track. *Average access time* is a truer measure of performance, as this figure adds in the time it takes not only to seek out the right track but also to position the head over the proper sector on the track. Look for an access time of less than 18 ms (milliseconds).

Finally, be wary of manufacturers' claimed *data-transfer rates*—the rate at which data is written to or read from a platter. They may cite *internal data-transfer rates*, the speed at which the drive can take information off the platter and into internal buffers, which is much faster than the *external data-transfer rate*—the speed at which data is actually transferred to your system. The data transfer rate is determined largely by your drive/system interface. Depending on your system bus/drive controller support (whether PCI, ISA, or EISA) and the data-transfer mode used, data-transfer rates of 2 MBps (megabytes per second) to 20 MBps theoretically may be achieved across the bus interfaces; 5 MBps to 8 MBps is a more

realistic external transfer rate from a single SCSI or EIDE hard disk today. If your system is set up for a SCSI drive, it is generally best to go ahead and spend the extra money for a SCSI hard disk.

Until recently, all drive heads were *inductive thin-film* heads that flew over the drive platters for read and write operations. Heads themselves are still made using thin-film technology (like processors), but some don't fly anymore. Others are no longer inductive, at least in the read operation. *MR* (magnetoresistive) heads enable manufacturers to get much higher data capacities per platter. This means they can pack the same capacities onto fewer platters, eliminate parts, and, as the saying goes, pass the savings on to you.

Proximity, or *semi-contact*, heads, are after the same end, but use the approach of taking the head so close to the platter that it comes in contact with the surface a significant percentage of the time. This used to be anathema to drive manufacturers, but improvements in micro-manufacturing technology have made it not only possible but profitable.

CAPACITY & PERFORMANCE

To make sure that you have enough hard disk capacity for all your needs—e-mail threads, Web downloads, digital photos, video, and memory-hungry graphics applications—buy a 2.1GB drive. Price: $360.

1. **Three platters.** The three-platter design lets makers deliver 2.1GB in a 3.5-inch, half-height form factor. Some vendors offer a 5.25-inch form factor drive.
2. **Rotational speed.** Although 4,500 rpm is fine for most users, the best desktop drives spin at 5,400 rpm. High-performance 7,200-rpm units are available for audio/video use but may be too noisy and hot for a desktop PC.
3. **Interface.** If your system supports SCSI, the performance gain is worth the extra cost.
4. **Head-to-head.** New head technologies, such as MR (magnetoresistive) and proximity thin film, deliver more capacity in less space.

Performance specs

- Look for an average access time of 18 ms or less. The internal data-transfer rate should be at least 5 MBps.

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THE PERFECT Removable Media

By Jamie Bsales • With removable mass storage, what is perfect depends on the user. Some types of storage drive stress low cost per megabyte, while others deliver quick access time and high data throughput. Some offer great portability, and still others boast shareability.

If you're looking for an inexpensive and easy way to back up your PC or a network server, tape is a good solution. These drives are available in internal and external units for individual PCs as well as jukebox configurations for networks. They are among the most affordable (as low as $150) and boast the lowest cost per megabyte of any mass-storage medium: as little as one-tenth of a cent. At the high end, 4-mm DAT (digital audio tape) and 8-mm tape drives each have long track records of reliability and are ideal for networked configurations. For the desktop PC or small server, the new *Travan* technology packs anywhere from 400MB to 4GB of data onto a tape, depending on the drive. The drawback is in performance: Since tape is linear, the drive must spin through the reel to reach the data you've requested; access time can be 30 seconds or more. So tape is best as a backup medium for files you rarely if ever need to access.

One of the hottest storage options these days is *CD-R*, or compact disk–recordable. These drives let you create your own CD-ROM disks (up to 650MB) from $7-apiece blank CD media. The drives have steadily been coming down in price and are available for as little as $500, though more typical prices range from $700 to $1,000. CD-R's allure is distributability: Because the vast majority of PCs come equipped with CD-ROM drives, you can create and distribute disks and be almost certain recipients can access the data. The capacity and relatively good performance—400-ms (400-millisecond) access time and 600-KBps (600-kilobyte-per-second) transfer rate—also make the disks ideal for multimedia presentations and training videos that would otherwise hog a hard disk. So far, though, CD-R software has been tough to work with for novice users, and the range of CD-ROM data types can be intimidating. But with a little practice (and a few wasted disks), most savvy users can be using CD-R for archiving, data distribution, and even creating their own audio CDs. The coming *CD-E* (compact disk–erasable) drives will let you rewrite disks.

A competing type of drive is Panasonic's *PD/CD-ROM drive* (about $500). These drives can read standard CD-ROM disks, and they can also write (and rewrite) proprietary 650MB cartridges ($45 each). With an access time of 165 ms and throughput of 870 KBps, they are much faster than CD-R drives and are ideal for storing large, often-used files and even entire applications.

Another popular category is proprietary cartridge drives. Iomega's *Zip drive*

(about $200) stores 100MB on each 3.5-inch cartridge ($15 apiece) and offers great portability for use with a laptop or for shuttling data between home and office. Iomega also offers its $500 *Jaz drive*. It can fit 1GB of data on each $99 cartridge. The *SyQuest EZ-135* (also $200) fits 135MB on each $20 cartridge, and it comes close to hard disk performance.

A possible threat to the Zip and EZ-135 comes from the next-generation floppy disk drive, the *LS-120*. Made by MKE, the floppy-disk-drive giant, and first incorporated into Compaq PCs, LS-120 drives can read traditional 1.44MB floppies, but they can also write new floppy disks that hold 120MB of information. Competing technologies are coming from other manufacturers, though, and it will be interesting to watch how this plays out.

Magneto-optical drives have been around for a while and are seeing a resurgence in popularity. MO drives come in two formats: 3.5-inch, with capacities to 230MB; and 5.25-inch, which can now write 2.6GB cartridges. Because of their excellent performance (20- to 50-ms access times and a 2-MBps transfer rate) and nearly indestructible media, MO drives are ideal for storing large amounts of frequently used data near-line.

If you need a cartridge drive system to shuttle files back and forth between your business and a service bureau (such as a prepress house), consider a drive like a 5.25-inch–format *SyQuest drive* ($350). These proprietary drives can fit 200MB or more of data per cartridge and are firmly entrenched in the desktop publishing and graphic-arts communities.

Looking forward, we can expect the coming DVD format to spawn *DVD-R*, perhaps by the end of next year. The successor to CD-R, DVD-R will let you create your own DVD disks to be read in DVD players, which should become standard over the next three to five years. These disks will hold up to 8.5GB on each disk and offer better performance than today's CD-R drives.

MORE SPACE

The choices for removable mass storage are many, and the list is growing all the time. Decide which attributes—transportability, shareability, speed, low cost per megabyte—are most important to you.

1. **Tape.** Sequential access makes it slow. But it's cheap per megabyte, and capacities are growing.
2. **CD-R:** Gaining in popularity thanks to the ubiquity of CD-ROM drives.
3. **Zip/EZ-135:** Very popular and reasonably quick; ideal for sharing or shuttling large files.
4. **PD/CD.** These dual-purpose drives can read CD-ROMs and write 650MB cartridges.
5. **LS-120.** This MKE/Compaq/3M device reads and writes 120MB and standard 1.44MB floppy disks. Competitors may emerge.
6. **Pinnacle Apex.** This proprietary-format MO drive promises 4.6GB capacity, though it has been vaporware for almost a year.
7. **DVD-R.** Still a couple of years away, these recorders will let users create DVD disks that hold up to 8.5GB on dual-layer disks.
8. **SyQuest drive.** Such proprietary-format cartridge drives are strong in the graphic-arts market.
9. **Magneto-optical.** Quick performance and durability of the media are the selling points.

THE PERFECT CD-ROM Drive

By John R. Quain • When developers started using CDs as storage media, CD-ROM players had an average transfer rate of 150 kilobytes per second (KBps). When the second generation of 300-KBps drives emerged, they were referred to as double-speed (or 2X) drives, and the race was on. We moved from 2X to 4X drives with 600-KBps throughput, then to 6X drives and their superior 900-KBps performance. Last spring, CD-ROM drive makers pushed ahead with 8X drives boasting a whopping 1.2-MBps (megabytes per second) average throughput.

If you already have a 4X drive, don't worry about the Joneses. Multimedia disks, the most demanding CD-ROMs of all, are written only for 2X or 4X drives. So going faster won't increase the performance of video and audio until multimedia software titles are written specifically for the faster CD-ROM drives. And if you're looking for a bargain, 4X drives can be had for under $100 on the street.

If you're shopping for the *perfect* CD-ROM drive, however, we suggest you consider an 8X drive, which will start around $250. Large databases of information can be accessed more quickly with a faster drive, and the peak 1.2-MBps data-transfer rate of an 8X drive will help get the data to you faster. When more demanding CD-ROM titles do hit the market, you'll be ready for them.

CD-ROM drive buyers will notice that prices vary by $100 or more among same-speed drives. Some of the cheaper supposedly 8X drives are actually "pushed" 4X drives with revamped software and firmware rather than new drive mechanisms. These drives can be less reliable than full 8X drives. Unfortunately, there's no way for the typical buyer to tell, so it's best to be suspicious of a bargain-priced 8X drive.

You might want to keep many CD-ROM titles on your system at the same time. You can do that with a CD-ROM changer. These models can handle four, over 6X perhaps even more than the straight performance boost does.

PERFORMANCE TESTS

CD-ROM Drives

PC MAGAZINE LABS

The performance characteristics of 4X, 6X, and 8X ATAPI and SCSI CD-ROM drives tracked as expected. More interesting were the results for CPU utilization, where we saw differences across both speed and interface variables.

What the Numbers Mean

In most cases, drives with a SCSI interface used less of the CPU's processing power to perform our real-world operations, leaving the CPU greater freedom to handle concurrent tasks. Also, 8X drives, with their better throughput, were notably less resource-hungry than 6X drives, a fact that recommends 8X

How We Tested

The **Sequential Read** test measures a drive's sequential data throughput rate. Each drive reads our entire test CD in 16K blocks.

The **Access Time** test measures the time it takes a CD-ROM drive to position its read head over a randomly selected data sector and read a 2K sector at that location. The average stroke distance is one-third of the entire CD-ROM disk.

The **CD-ROM WinMark 96** test suite plays back CD-ROM operations from a profile of six of the most popular Microsoft Windows CD-ROM applications. The test takes the average transfer rate for each application and uses a weighted harmonic mean to calculate the average transfer rate for the PC's CD-ROM subsystem.

The video playback tests show performance and CPU utilization characteristics of a variety of CD-ROM video types.

	CD-ROM Sequential Read (Kilobytes per second)	CD-ROM Access Time (Milliseconds)	CD-ROM WinMark 96 (Score)	Intel Indeo Video (320 x 240 resolution, 30 fps, 600 KBps)			Cinepak Video (320 x 240 resolution, 30 fps, 300 KBps)			Cinepak Video (640 x 480 resolution, 30 fps, 900 KBps)		
				Audio breaks	Frames dropped	CPU utilization	Audio breaks	Frames dropped	CPU utilization	Audio breaks	Frames dropped	CPU utilization
ATAPI INTERFACE												
Hitachi 4X	612	244	424	0	0	62%	0	0	44%	5	454	98%
Hitachi 6X	1,080	168	672	0	0	60%	0	0	43%	0	0	83%
Hitachi 8X	1,220	159	735	0	0	54%	0	0	46%	0	0	68%
SCSI INTERFACE												
Plextor 4X	689	135	547	0	0	52%	0	0	40%	4	417	96%
Plextor 6X	910	153	613	0	0	56%	0	0	42%	0	18	93%
Plextor 8X	1,220	117	847	0	0	47%	0	0	36%	0	0	58%
	BETTER ▶	◀ BETTER	BETTER ▶									

Lower scores represent better performance.

five, six, or even seven disks at a time, but they run only at quad speed right now. If you're constantly swapping disks in and out of your CD-ROM drive, however, a $280 4X changer could save you more time than a single-disk 8X drive.

Just as buyers start to ponder the 8X speed enhancements, some companies are announcing still faster—10X—drives. Pioneer New Media Technologies is expected to be the first out of the blocks with its Super 10X drive.

This fall, several manufacturers are expected to introduce new drives that can operate at 8X and play regular CD-ROM titles as well as disks containing 4.7GB of information—a huge leap over current 650MB CD-ROMs. DVDs (which has alternately stood for digital video disks and digital versatile disks) are the same diameter as current CD-ROMs, and the first drives for computers are expected to be priced in the $500 to $700 range. Should you wait for a DVD drive? The short answer is no. It will take months before software developers produce titles specifically for DVD, and because of the huge installed base of CD-ROM drives, they will doubtless continue to produce CD-ROM disks for years to come.

8X SPEED

Although 4X drives are sufficient to read the current crop of multimedia CD-ROM titles, if you're buying today, opt for an 8X drive to stave off obsolescence. A 4X multidisk changer may save you more time than a single-disk 8X drive. Price: $250.

1. **True 8X.** If you find an 8X drive that seems too much a bargain, beware. Some vendors are selling 4X drives that have been speeded up to 8X specs, but these drives don't give true 8X performance in most real-world applications.

2. **Creature comforts.** Since you may also want to play audio CDs, look for a drive with play and track-skip buttons, as well as a headphone jack.

3. **Changers.** If you find yourself swapping disks often, consider getting a multidisk CD changer. Both internal and external drives are available.

Other important points:

- 2-MBps throughput. Gives speedy access to the CD-ROM–based information you may also want.
- On the horizon: The looming 10X and DVD drives mean we'll have to reconsider all of this a year from now.

There are other ways to accelerate your multimedia, but may we suggest our new Graphics Blaster.

Multimedia can be a frustrating thing. Even on today's hottest systems, video playback can end up looking like a postage stamp with fewer colors than you get from a box of crayons. Or, when you zoom it to full screen, it looks like a slide show instead of a smoothly running movie. Before you resort to extremes, you might want to try our new Graphics Blaster™ multimedia accelerator from Creative Labs.

Graphics Blaster features high-tech video acceleration functions like asymptotic scaling, horizontal and vertical filtering and color space conversion built right into the hardware. The end result is video that glides onto the screen in dazzling true color without dropping frames. And the powerful 64-bit graphics engine delivers Windows® performance that will blow you away.

Best of all, Graphics Blaster won't blow away your bank account. Our top-of-the-line Graphics Blaster MA302 with 2MB of state-of-the-art Rambus memory — the same high performance memory used on Silicon Graphics workstations — costs less than comparable boards using yesterday's tired VRAM memory.

So when you're ready to boost your graphics and video performance to the stratosphere, pick up a Graphics Blaster at your nearest Creative Labs dealer. It's got the multimedia muscle your system deserves. What else would you expect from Creative Labs, the leader in high-performance multimedia products.

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CIRCLE 095 ON READER SERVICE CARD

THE PERFECT Sound

By Holly Aguirre • Over the years, sitting down in front of a PC has become much more involved than simply using Excel spreadsheets and word processing. CD-ROM titles rich in sound, multimedia presentation creation, videoconferencing, and telephony, as well as such recreational activities as playing games and listening to audio CDs while you work, require that sound be an integral part of the perfect PC. To complement that much-toiled-over sales presentation or to download a sound bite of Homer Simpson, you'll want the perfect sound board. And gamers will delight in the new 3-D acoustic offerings.

BEYOND THE BASICS

Most PCs now come equipped with multimedia, and most PC vendors now include good-quality sound cards that deliver *wavetable synthesis*. Wavetable technology enables your computer to play back the prerecorded sounds of actual instruments. Cheaper boards often rely on *FM synthesis*, using programmed sine waves to produce less-than-believable instrument reproductions—the bleeps and bloops of last-generation arcade games or calliope-like musical passages. An on-board wavetable chip contains prerecorded, digitized samples of actual musical instruments and sound effects. The difference is obvious: Music tracks are more convincing and action games more intense.

If sound quality is important—say, for those who build multimedia presentations, compose music on their PCs, or use their machines for serious gaming—chances are you'll want to upgrade to a better card than the one that came with your system. This can be achieved for about $200 retail. For this investment you get true CD-quality stereo recording and playback using 44,100 16-bit digital samples per channel every second, better wavetable samples, and other extras.

The ability to support *General MIDI* (musical instrument digital interface) will prove an indispensable part of your perfect sound board. MIDI is a standard set of commands that can be issued by an electronic instrument (such as a keyboard) or an application (such as a game). The MIDI command tells the synthesizer which instrument to play, at what pitch, and for what duration. Since a MIDI command demands less storage than digitized sound files, it is prevalent in game and edutainment titles. But you'll need a MIDI-compatible card to be sure you're getting the sound the developer intended. Note that not all wavetable sample sets are created equal, however; the MIDI composition of a title or of your own making could be fine, but the wavetable samples delivered by a lesser sound card could be disappointing. Also, you'll want *Sound Blaster compatibility;* this Creative Labs specification is widely used in DOS games and is a must if you're a game player.

What's New Online

Want to learn more about the Perfect Peripheral Bus, Perfect Graphics Adapter, Perfect Monitor, Perfect Hard Disk, Perfect CD-ROM Drive, Perfect Removeable Media, and Perfect Sound Components we talk about on these pages? Then join *PC Magazine*'s hardware editors and their team of writers from June 24 through June 28 in *PC Magazine*'s Editorial Forum on CompuServe (GO PCMAGNET). Also joining us will be representatives from major vendors in each product category.

More business-oriented users may want to opt for a card that combines sound functionality with communications functions. With specialized chips called *DSP*s (digital signal processors), these combination cards provide basic PC sound while adding functionality such as telephony, fax, and voice mail. The newer configurations even integrate voice recognition and text-to-speech features, so you can control your computer via voice commands and retrieve your e-mail remotely. Keep in mind that you'll need the right software. There are many sound boards that simply focus on quality sound reproduction without extras, but they also use custom DSPs for special sound effects like echo, reverb, and flanging.

While most sound cards have a built-in amplifier, the signal is generally weak (only 4 watts per channel, with high distortion), even on better cards. This means that the perfect sound system requires a set of self-powered speakers, which have their own power source and amplifier built in. Most of the "courtesy" speakers that come bundled with multimedia PCs produce noise and distortion, and the power amplifier will alleviate this problem.

The best way to go is with a three-piece system: two small satellite speakers designed to handle mid- to high-range frequencies (from 150 Hz to 20 kHz) and a separate subwoofer for lower frequencies (20 Hz to 150 Hz). The subwoofer produces the richer bass missing from a two-piece set of speakers. With its bread-box size, it can easily be hidden under your desk. PC speakers are designed to produce more directional sound; unlike regular stereo components, they should be placed closer to the user for better sound—about 2 feet away. Computer speakers are also magnetically shielded to prevent any interference with your display.

PC speakers are a sexy item these days, and you could easily spend $250 or more. Unless PC sound drives your livelihood, though, look for a set that delivers 30 watts of power (enough to fill an office with sound without distortion) for about $150. Finally, look for features such as an up-front headphone jack, volume and balance controls, and bass and treble knobs.

DIMENSIONAL SOUND

The hottest ticket in sound these days is so-called *3-D sound*. Sound-card and speaker vendors have teamed up with companies such as Binaura Corp., Dolby, Q-Sound, Spatializer, and SRS to add dimensional effects to the sound being generated. These effects serve to widen the stereo field to give more depth to the inherently shallow listening field of most small, closely spaced PC speakers.

Most 3-D effects are caused by mixing specifically delayed versions of the left

and right channel outputs with the original signal, simulating reflections off walls, or adding spaciousness and directionality to the sound. This approach is used by Binaura, Spatializer, and SRS. Even better are the sound effects of Dolby Pro Logic and Q-Sound, which let multimedia developers pinpoint sounds in space and move them around the listener. These effects must be programmed into the multimedia title, however, and you must have a sound card or speakers designed to deliver the desired effect. Those inclined to blast off into the universe after hours will enjoy the enhanced effects, but purists eager to hear every harpsichord note in a Mozart piece should probably stay away. □

WAVETABLE *For realistic sound reproduction from multimedia titles, insist on a sound card with wavetable synthesis, not just the poorer FM synthesis.* Price: $200.

Your speaker set should include two satellite speakers and a subwoofer. Price: $150.

1. **True CD-quality stereo sound.** The card must deliver 16-bit 44-kHz stereo sampling
2. **Wavetable synthesizer.** The synthesizer should deliver 4MB of accurate, high-quality samples (compressed to 2MB of ROM).
3. **3-D sound enhancement.** Spatial effects can add depth to games and music.
4. **Digital signal processor.** An on-board DSP can add special features such as telephony.
5. **External connectors:** SCSI or IDE connector for CD-ROM drive and other peripherals.
6. **Powered speakers with subwoofer.** The set should have controls that are easy to manipulate; a mute button is a plus.

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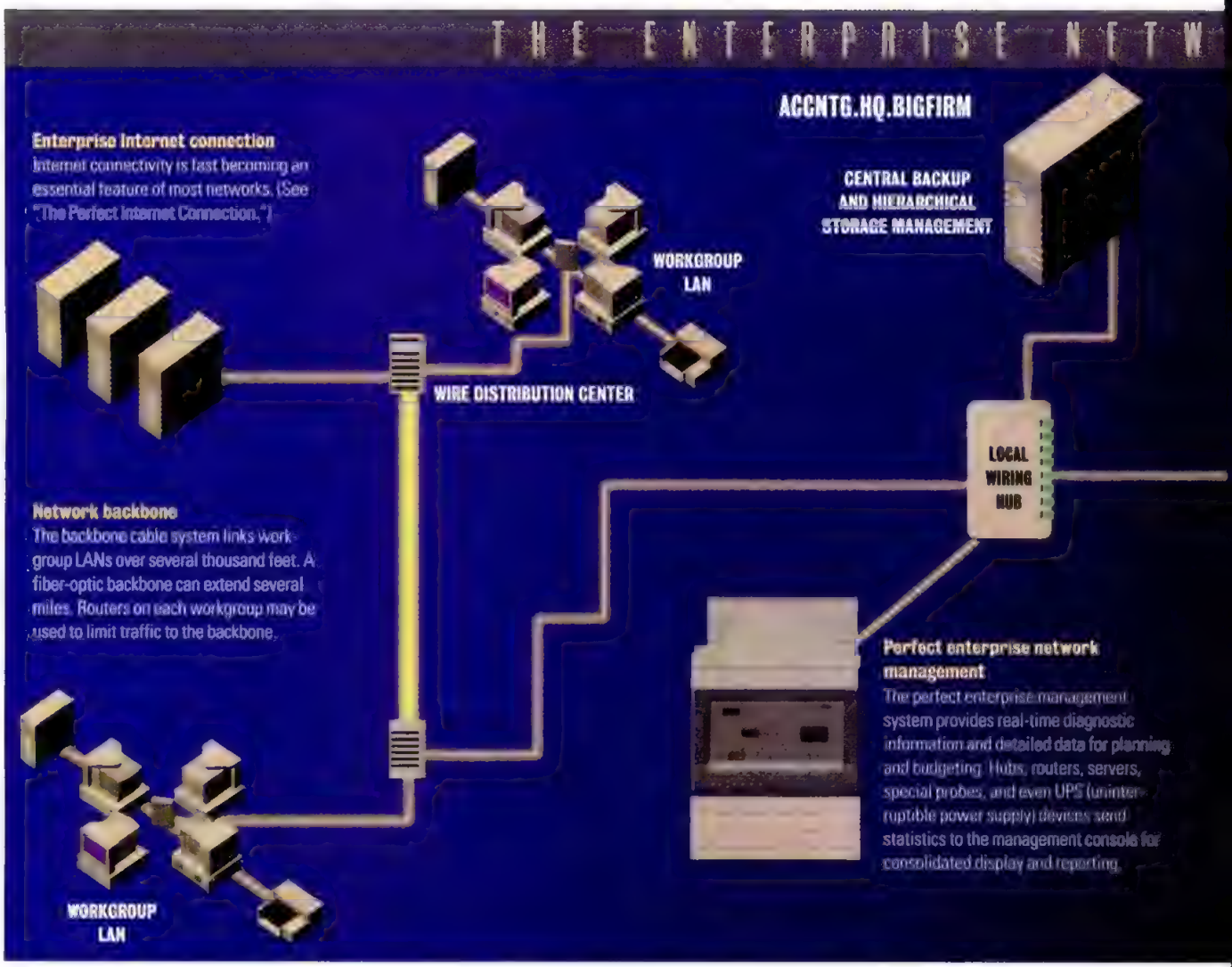
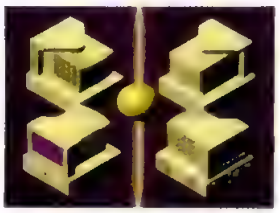
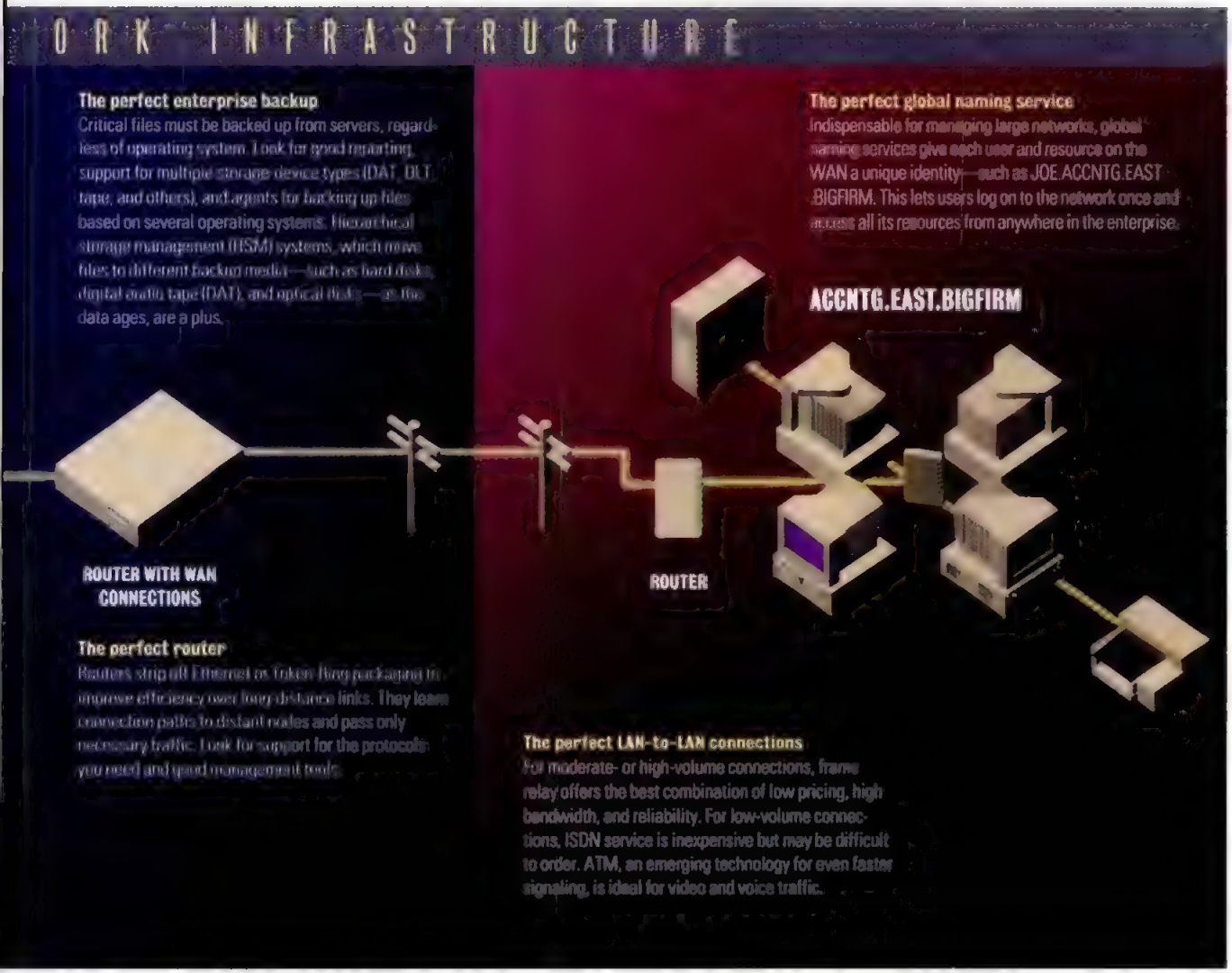


The Perfect Connections

The challenges of designing the best networking infrastructure have, if anything, become more complex. While the Internet and intranets have grabbed the spotlight, the problems of network segmentation, isolation, management, and backup haven't gone away.



On the following pages you'll find our representations of the best way to connect people and resources in your corporation, workgroup, or small office. Our recommendations take in newer trends like Internet access and intranets, but we also include information on mainstream networking topics like remote access, fast networking, switching, routing, network operating systems, and naming services.



THE PERFECT Enterprise Network Infrastructure

By Frank J. Derfler, Jr. • The design of the perfect enterprise network infrastructure must evolve and allow for flexibility. We've found that major enterprise components such as WAN transport services, routers, naming services, centralized backup, and network management products become more specialized even as they become more flexible.

We'll start from the outside edges of the enterprise and work our way into the corporate center. Despite the emphasis on flatter organizational structures, most data communications still take place between corporate headquarters and the branch office. Network traffic studies and projections are important for WAN planning, but so is the flexibility to accommodate unforeseen corporate acquisitions, mergers, downsizing, and outsourcing.

Corporate data networks in the U.S. depend on leased telephone lines, which are reliable and economical. But that's changing. Frame-relay services, available from such companies as CompuServe and telephone companies, move packets of data more cost effectively, with much more flexible connection options, and as reliably as leased lines. We recommend mixing frame relay for moderate- to high-volume connections and ISDN for low-volume WAN connections.

Some organizations are considering cutting connection costs by putting WAN traffic on the Internet. We don't recommend it, because today the reliability and security just aren't there.

While routers remain critical to wide-area network operation, they're getting more affordable and evolving into different subspecialties. Routers segregate traffic by destination so that local traffic doesn't crowd long-distance links. Competitive prices and features come from every corner. 3Com sells low-cost routers for remote-office connections to a central site. Cisco and Novell offer router software that runs within a server—saving on hardware costs. Routers play important

THE NETWORKING TOP TEN

Shown below are the top ten LAN hardware vendors, ranked in order of total revenue based on information from the vendors and The Dell'Oro Group, a market-research firm based in Menlo Park, California.

Rank	Company	Address	Telephone	Web site	Products
1	**Cisco Systems Inc.**	San Jose, CA	800-326-1941, 408-526-4000	*http://www.cisco.com*	Hubs, network interface cards, routers, switches
2	**Bay Networks Inc.**	Santa Clara, CA	408-988-2400	*http://www.baynetworks.com*	Hubs, network interface cards, remote-access servers, routers, switches
3	**3Com Corp.**	Santa Clara, CA	408-764-5000	*http://www.3com.com*	Hubs, network interface cards, remote-access servers, routers, switches
4	**IBM Corp., Networking Hardware Division**	Research Triangle Park, NC	800-426-2255	*http://www.ibm.com*	Hubs, network interface cards, routers, switches
5	**U.S. Robotics Corp.**	Skokie, IL	708-982-5010	*http://www.usr.com*	Remote-access servers
6	**Cabletron Systems Inc.**	Rochester, NH	800-332-9401, 603-332-9400	*http://www.cabletron.com*	Hubs, network interface cards, remote-access servers, routers, switches
7	**Digital Equipment Corp., Network Product Business**	Littleton, MA	800-457-8211, 508-692-2562	*http://www.networks.digital.com*	Bridges, hubs, network interface cards, routers, switches
8	**Hewlett-Packard Co., Workgroup NetWorks Division**	Roseville, CA	800-533-1333	*http://www.hp.com*	Bridges, hubs, network interface cards, routers, switches
9	**Madge Networks Inc.**	San Jose, CA	800-876-2343	*http://www.madge.com*	Bridges, hubs, network interface cards, routers
10	**UB Networks Inc.**	Santa Clara, CA	408-496-0111	*http://www.ub.com*	Hubs, network interface cards, routers, switches

roles in Internet and intranet access and in remote LAN access—topics we discuss more in the following pages.

THE BACKBONE

The corporate backbone is a high-speed extension of the WAN links. The primary backbone choice for big sites has been fiber-optic cable with segments isolated by routers. Internal routers now face stiff competition from 100-Mbps Fast Ethernet switches, and those switches are being challenged in turn by switches using asynchronous transfer mode (ATM). The small size of the ATM cells (as individual ATM data packets are called) reduces the maximum delay, or latency, experienced by any cell. So ATM is great for delay-sensitive apps that use sound and video. But ATM standards are not yet complete, and at present ATM components are relatively expensive.

MANAGING THE WAN

Network management alternatives clearly illustrate the combination of specialization and flexibility. Enterprise network management console systems—such as Bay Networks' Optivity series, Hewlett-Packard's OpenView, and SunSoft's Solstice—gather performance and operational data from across the WAN via the Simple Network Management Protocol (SNMP). These systems provide manual and automatic control of WAN and internal backbone operations. The development of the SNMP Remote Monitoring (RMON) database made it practical to put reporting capabilities in wiring hubs and even into special-purpose network-connected devices called probes.

At the same time, management systems—such as McAfee's BrightWorks and Saber LAN Workstation, Seagate Enterprise Management Software's Frye Utilities for Networks, Intel's LANDesk Management Suite, Microsoft's System Management Server, and Novell's ManageWise—monitor the status of each server in detail. They provide various levels of inventory reports on the hardware and software connected to LANs and take care of such tasks as distributing software updates and running virus checks. (For more information, see "LAN Tamers," November 21, 1995.)

Network backup is a separate but equally critical management issue. Enterprise backup systems back up not only file servers, but also Web servers, mail servers, and individual PCs. Administrators have a wide set of options for media including magneto-optical and phase-change devices able to store more than a gigabyte per platter. Multi-CD jukeboxes can serve as the second line of storage in hierarchical storage management (HSM) systems. HSM software from Avail, Cheyenne, IBM, Seagate, and other companies automatically moves less frequently used files off the hard disks and out to more flexible storage, while still keeping the files available for use.

Remember, the ability to back up data is interesting, but it's the ability to restore data that counts.

THE NAME GAME

The need for flexibility also shows itself in network naming and directory schemes. The old model is for each user to log on to each server, but this assumes high user expertise and creates a lot of work for the administrator. A global naming service, a structure pioneered by Banyan's VINES and now adopted by Novell in NetWare 4, provides a way to name people and network resources across the enterprise. In this type of system, users can log on from anywhere in the enterprise and immediately have their standard rights to files and resources. Microsoft Windows NT Server has a similar directory structure, based on domains, that can allow users a single log on to all resources. Administrators can quickly locate and manage resources for their users. To make this possible, local servers replicate and update a global table of resources throughout the enterprise.

A structure like NetWare Directory Services (NDS) allows third-party developers to write their own links into the service. Many products, including HSM programs and many management programs, can read NDS entries, so they can tap into and describe the network in accurate and commonly understood detail.

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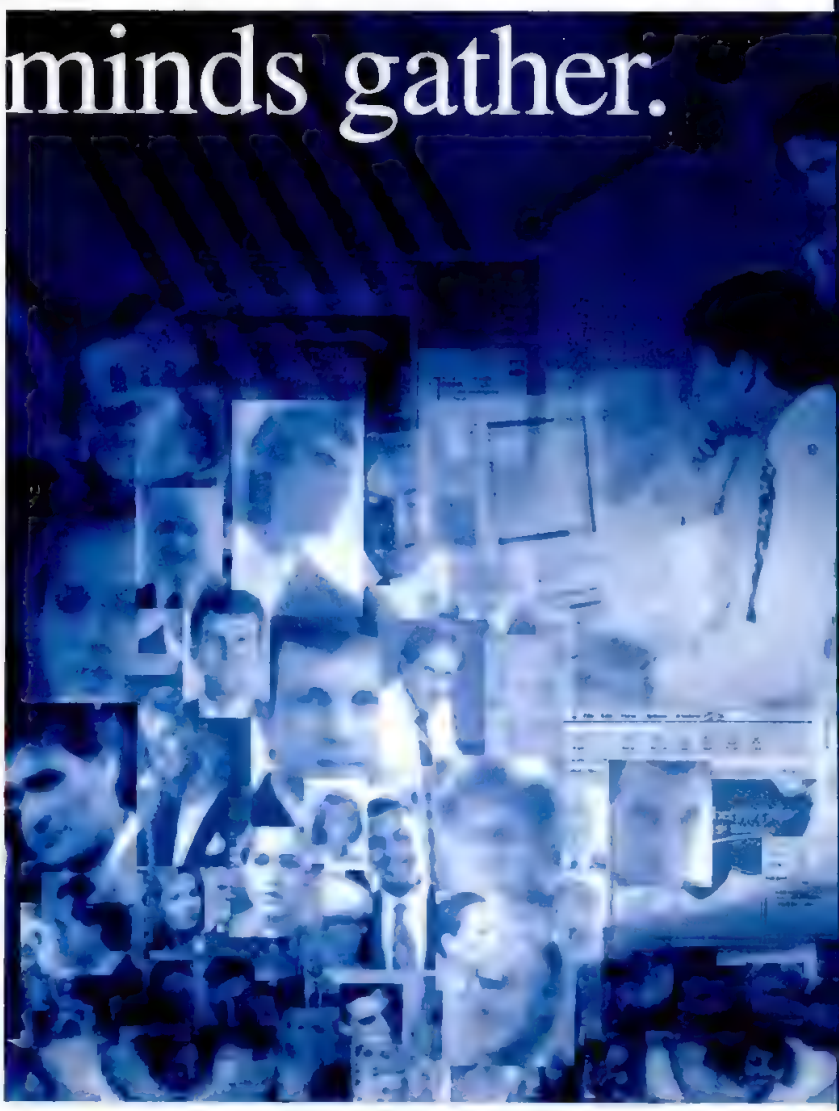

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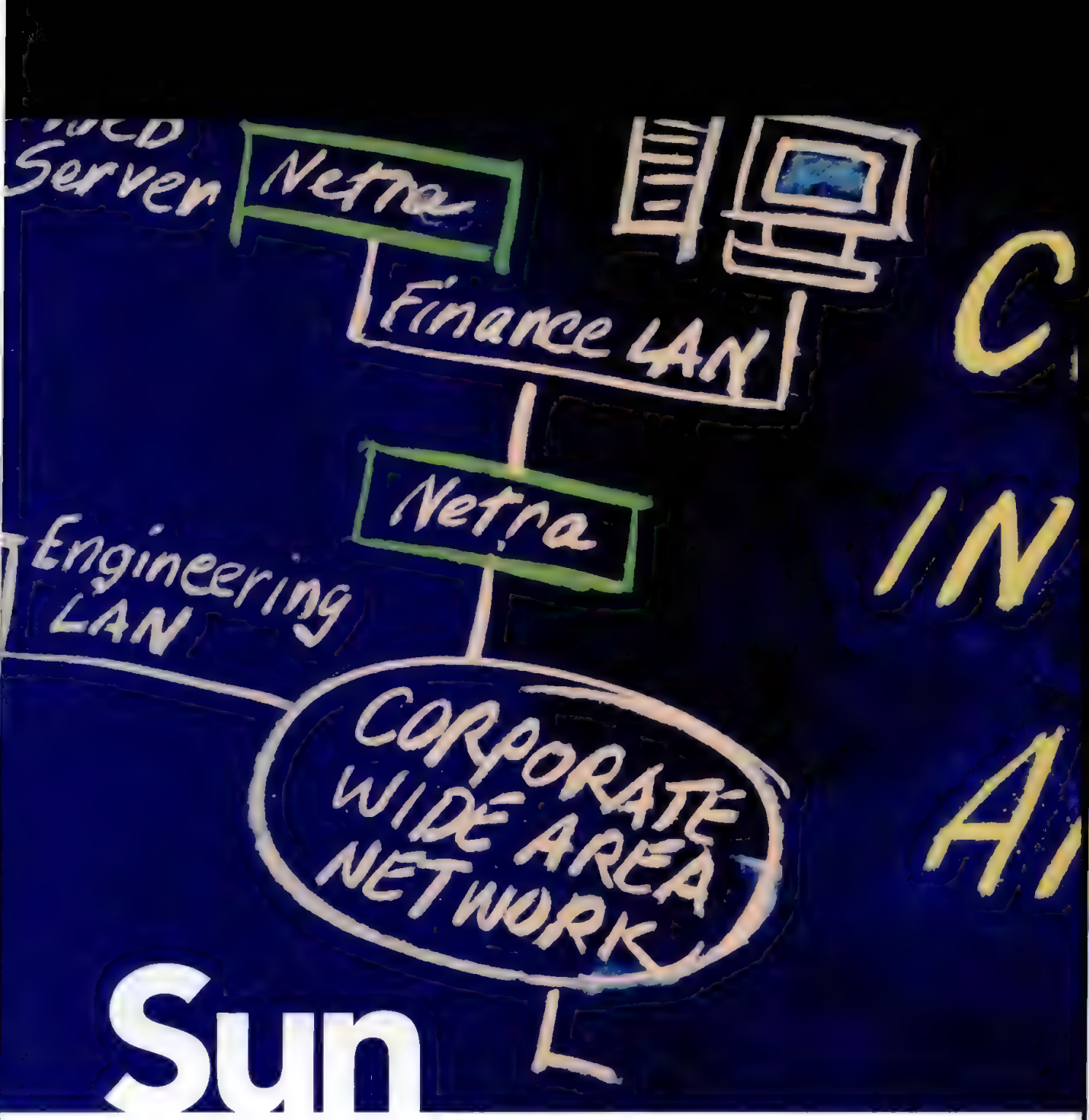

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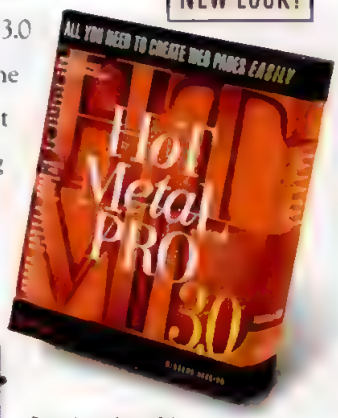

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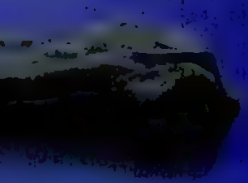

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THE PERFECT Internet Connection

By Thomas Mace • The Internet sounds like a single entity, but it is really a remarkably diverse collection of communications protocols, applications, and the infrastructure that supports them. Although all Internet installations have some elements in common, your configuration depends on what kinds of applications you wish to support, how you want your users to connect, and the type of performance and security you require.

Our perfect Internet diagram assumes that you want the four most popular Internet applications: Web browsing, e-mail, Usenet newsgroups, and FTP (file transfer protocol) access. Our perfect Internet connection also includes a state-of-the-art Web site and FTP server to present your content to the outside world. It assumes that your organization needs high performance for both inbound and outbound applications and a high level of security for the corporate network. It makes provisions for limiting Internet access privileges for some workgroups and does not assume that all workgroups run TCP/IP, the Internet's native protocol. It also makes provision for remote users to use Internet client applications through remote dial-in connections.

THE PERFECT INTERNET CLIENT

The ideal Internet client PC begins as an ideal PC. It should have a fast processor to make HTML rendering as fast as possible, at least 16MB of RAM to run today's increasingly feature-rich browsers, and plenty of disk space for applications, downloads, and HTML-page caches. You'll also want to have hardware-assisted graphics acceleration, support for 16-bit color, a sound card, and speakers to handle graphics-laden Web pages and all the Web's new multimedia technologies. A number of off-line Internet search tools, such as Frontier Technologies' CyberSearch, also require a CD-ROM drive.

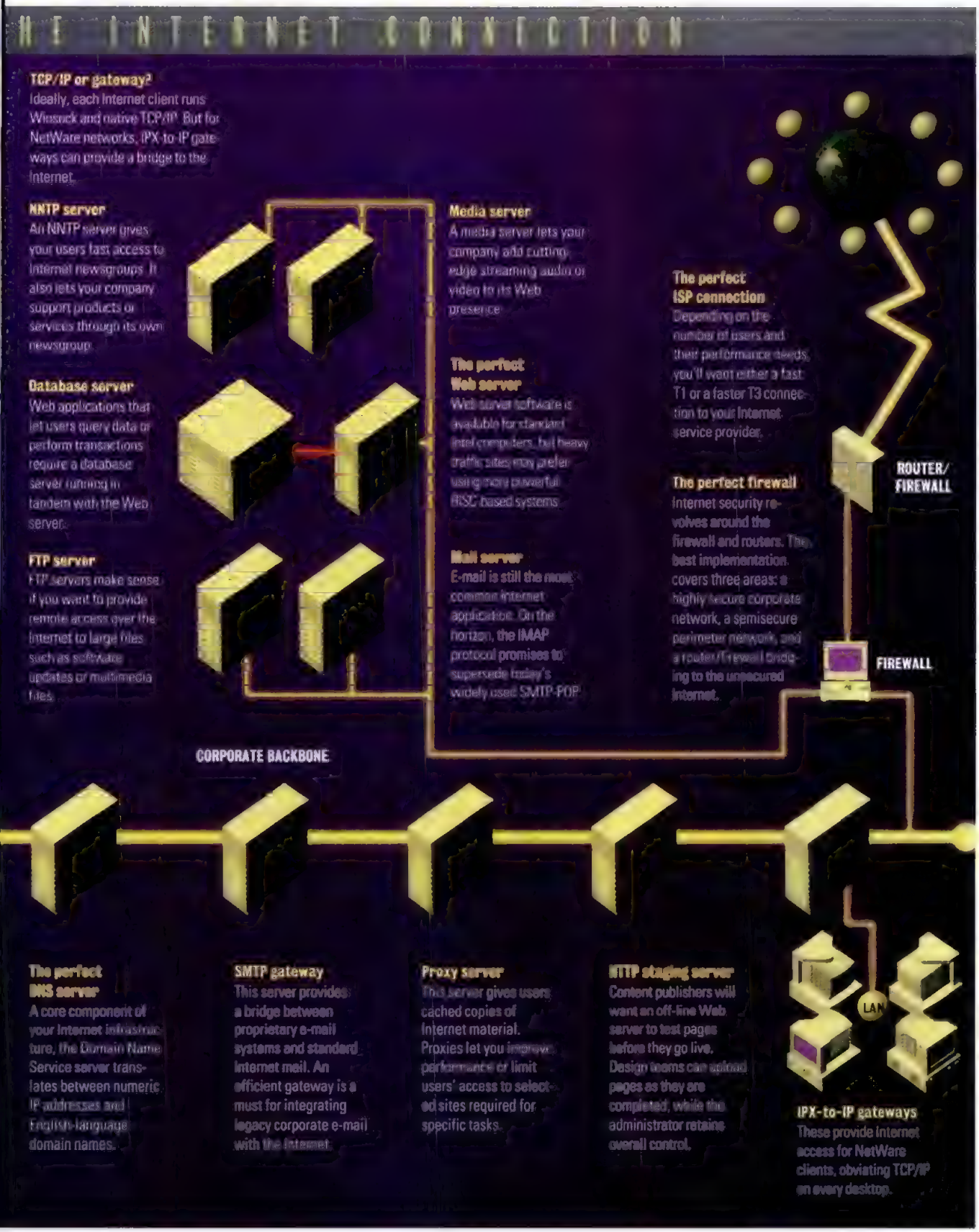
Many state-of-the-art Internet client applications for sending and receiving e-mail, reading Usenet newsgroups, sending and receiving files via FTP, or Web browsing are available for free, sometimes on a trial basis. In some cases, site licenses for corporations may be required. Of these four application types, browsers have become by far the most complex and are quickly incorporating many other applications. The overwhelming market leader today, Netscape Navigator, provides support for standard and proprietary HTML tags, includes in-line graphics viewers, exposes an API for developing plug-ins that extend its functionality, and includes a Java language engine. It also includes a full-fledged Internet mail client and a capable Usenet news reader.

Navigator and most other standard Internet applications work with Windows Sockets (Winsock), a standard API that allows applications to use the TCP/IP protocol. This three-tier system—with the Winsock middleware between the application and the TCP/IP protocol—makes it possible to mix and match client applications and TCP/IP stacks without worrying about protocol-to-application compatibility.

The most straightforward arrangement for connecting clients to the Internet is to assign an IP (Internet Protocol) address to each PC. If your organization does not have access to sufficient IP addresses or does not plan to run the TCP/IP protocol on all clients, IPX-to-IP gateways offer an alternative. Products such as Firefox Communications' Nov*ix for Internet run on a server to provide translation between IPX and IP packets, letting NetWare clients run Internet client applications.

If your organization wants to limit some users' access to a subset of World Wide Web sites, proxy servers provide an answer. These servers mirror a site or group of sites behind your corporate firewall. Users access the mirror image rather than communicate directly with the remote Web servers. Proxy servers can also be used as a way to improve performance of slower external sites dramatically. Proxy servers typically require large amounts of high-performance hard disk storage, especially if the number of cached external pages is high.

THE INTERNET CONNECTION



CORPORATE INFRASTRUCTURE

One of the most important elements in the corporate Internet infrastructure, the Domain Name Service (DNS) server, is also one of the more obscure. This server maintains a list of cross-references between cryptic IP addresses and English-language DNS names. Inside the corporate domain, the DNS server keeps information on all named users and servers so that traffic gets routed to the correct physical machine. The DNS server also keeps basic domain information for the entire Internet, so that when you request a Web page from an external server—*www.pcmag.com,* for example—your request winds up at the right remote server, even if it is thousands of miles away.

Slow DNS response can be crippling to your overall Internet performance. The ideal DNS server will have sufficient memory to cache the entire set of DNS lookup tables in RAM.

Many corporations will also implement Internet mail, which is still one of the Internet's most widely used applications. Of the four mail protocols in use—SMTP (Simple Mail Transfer Protocol), X.400, POP (Post Office Protocol), and IMAP (Internet Message Access Protocol)—SMTP is by far the most common.

Legacy-to-SMTP gateways provide a bridge between Internet mail and proprietary communications systems such as Lotus Notes. An ideal gateway, not often found in practice, seamlessly handles attachments and rich data formats as well as text.

PUBLISHING TO THE WORLD

One of the most attractive features of the Internet is the power it gives corporations to broadcast information. Most of this effort is going into developing content for the World Wide Web, whose servers use the Hypertext Transfer Protocol (HTTP). The type of physical server you choose to deploy depends a lot on the amount of traffic you anticipate. Although server software is available for Intel-based PCs running Windows NT, NetWare, and Unix, many heavy-duty servers are based on RISC processors such as Digital's Alpha, Silicon Graphics' MIPS, and Sun's UltraSparc systems.

On many HTTP servers, pages are stored in a conventional file system with directories and subdirectories. Increasingly, site managers are finding that this is becoming unmanageable for very complex sites that need to be updated frequently. A common solution is to store Web content in a database linked to the HTTP server through Common Gateway Interface (CGI) scripts. In this system, page requests effectively become database queries. Managers can easily maintain content by updating the database. Databases also form the basis of interactive Web applications that provide responses to user queries or execute sales or other transactions.

Multimedia is quickly becoming an important component of many Web sites. Many multimedia formats are simple download-and-play technologies where the end user receives an entire file that is executed by a helper application or plug-in. Examples include simple AVI video and multimedia formats such as Macromedia's Shockwave for Director. More powerful streaming multimedia technologies, which play a continuous data stream as it arrives at the user's PC, benefit from a dedicated server on the playing end. Examples include Progressive Networks' RealAudio and Xing Technology's StreamWorks, a video-streaming application. (For more about Internet multimedia, see "Audio. . . Video. . . Live from the Web," March 26, 1996.)

File Transfer Protocol (FTP) and Network News Transfer Protocol (NNTP) servers offer simpler ways to disseminate information to the outside world. FTP servers make sense where you wish to make large text or binary files remotely accessible. End users see the server's contents as a standard file structure. NNTP servers make sense if you wish to support a company product or service through Usenet's threaded messaging interface.

SECURITY AND CONNECTIONS

So far, we have discussed Internet applications without considering security issues. But security is of paramount importance since the Internet effectively connects your corporate network to the rest of the world.

Internet security revolves around specialized server software called firewalls that can differentiate between traffic that you want to let in (Web pages and e-mail for example) and traffic you don't (such as requests to read files on your corporate file servers or workgroup clients).

Though a number of security configurations are possible, a good practice is to group your applications in one of three network areas depending on the security requirements. All three areas interface at the firewall.

The clean-net or most secure area contains the workgroup clients and file servers and any application servers that need to be closely associated with them for performance reasons. A second perimeter network, which has a lesser degree of protection, can be used to deploy applications that generate outbound or two-way traffic. These include your company's Web and media servers, FTP and NNTP (news) servers, and possibly your Internet mail server. Finally, the firewall also connects through a router to your Internet service provider. Anything beyond this connection is "dirty-net," or totally unsecured. The bandwidth of the connection to your service provider depends on your overall traffic requirements. Possibilities include T1 (1.544 Mbps), T3 (about 45 Mbps), or several bonded lines of either speed. Small businesses may get by with an ISDN connection if they expect light traffic.

For More Networking

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Article	Date
A Billion-Node Network (computer telephony)	June 11, 1996
Routers in All Places (remote-site routers)	May 28, 1996
Your Server's Double (server fault tolerance)	May 14, 1996
ATM on the Move (ATM adapters)	April 23, 1996
LAN on Demand (ISDN routers)	April 9, 1996
Your Defensive Line (firewalls)	March 12, 1996
Backup to the Future (network backup)	February 20, 1996
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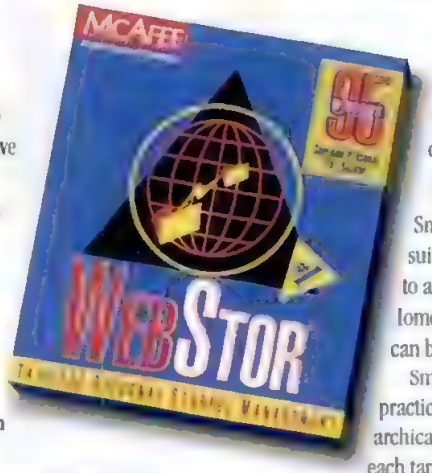

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THE PERFECT

Network Operating Environment

By Frank J. Derfler, Jr. • Network operating systems that feature simple file and printer sharing are an endangered species. Evolved networks have layers of services that make up what we call the *network operating environment.* Interoperability and rich built-in or tightly integrated network-based services are the prime features of a network operating environment. The NOSs that compete as network environment platforms include Microsoft Windows NT Server, Novell's NetWare, IBM's OS/2 Warp Server, and various flavors of Unix. (For more information, see "The NOS Evolved," May 28, 1996.)

The ability to use several different network transport protocols is the keystone of a network operating environment. Microsoft emulated Novell's IPX/SPX protocol in Windows 95 and Windows NT Server, and virtually every NOS now makes it easy to use TCP/IP, the protocol of the Internet. Because applications running on PCs in these environments can call on various transport protocols, they have access to a variety of print, file, communications, and database services. Multiprotocol environments increase a desktop PC's RAM needs and make management more complex, but that's the price of providing more network services to your users.

Modern network operating systems also make it easy to communicate over a variety of different links. The dial-up networking in Windows 95, for example, allows people to pull data across ISDN or frame-relay links as easily and as invisibly as they can from LAN connections. And you can connect a single- or multiple-transport protocol to a serial port or internal ISDN adapter as easily as you can to a LAN adapter.

THE UNIVERSAL CLIENT

Some desktop PC network operating systems, particularly OS/2 Warp Connect and Windows 95, come with or have available client software for several brands of server software. For example, someone networking under OS/2 Warp Connect or Windows 95 can have drive letters assigned to servers running NetWare, OS/2 Warp Server, and various flavors of Windows. It's also easy to add client software for a Unix server that uses the Network File System (NFS), a de facto Unix standard originally developed by Sun Microsystems. The client operating system's ability to talk to multiple servers makes it practical to use a NetWare server for its excellent file and print service while simultaneously assigning another drive letter to an OS/2, Windows NT Server, or Unix server in order to run applications. File and print services may be a commodity, but competition is hot in application services. An application server runs some specialized program, like an e-mail post office, Web server, fax gateway, or telephony controller, that applications running in networked PCs use.

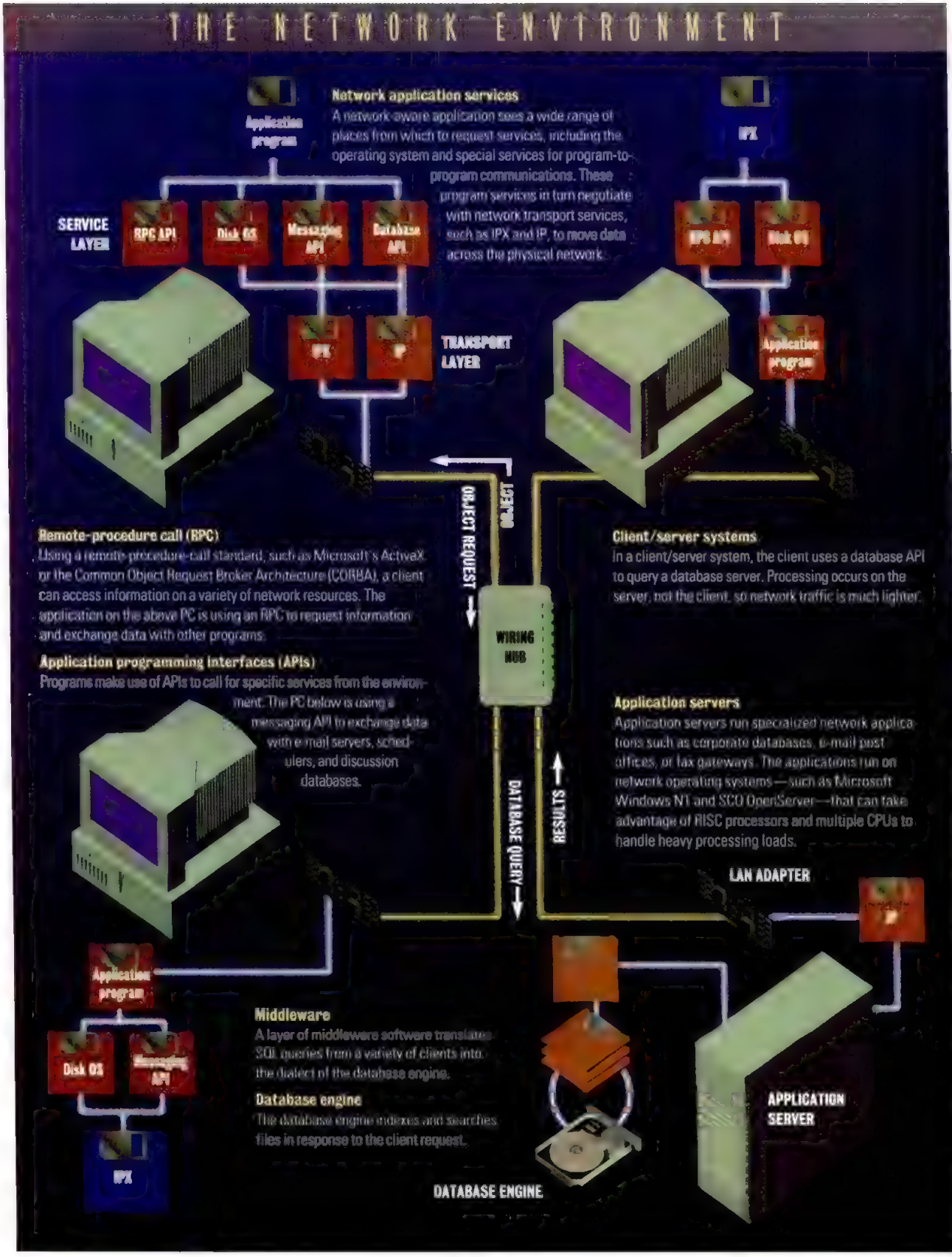
Network operating environments incorporate highly integrated services and standards for smarter, richer, and better-connected networks.

These application servers typically benefit if they have access to a global naming service so they can quickly identify users and resources. They also perform much better if they can use multiple Intel-based processors or RISC-based processors—such as Digital's Alpha, Motorola's Power PC, and Sun Microsystems' UltraSparc—for heavy processing loads. Windows NT Server leads the NOS pack when it comes to hardware flexibility and scalability. (For a review of application server operating systems, see "Serving Up Apps," October 24, 1995.) Client/server systems blend application server and file server functions.

Client programs use the IP or IPX transport to carry requests to a database server. This server can be a PC equipped with a heavy-duty storage system or even a mainframe running a time-proven database. The mainframe might use another layer of software, called middleware, to translate between the client queries and the database. In either case, a program in the database server does the indexing and sorting tasks for the applications, thereby reducing the traffic load on the network and the workload at each client.

Network operating environments offer more services to applications as application programming interfaces (APIs)—formats that programmers use to call for specific services from the environment. Examples of these include a messaging API, such as Microsoft's Messaging API (MAPI), that carries shorthand forms of requests and replies between application servers and clients. A telephony API such as Novell's Telephony Server API (TSAPI) lets applications control desktop telephones and PBX functions. And remote procedure calls (RPCs), such as Microsoft's ActiveX specification, give client-side programs sophisticated ways to move objects and information among networked programs.

The evolution will continue as Microsoft and IBM introduce more interprogram structures into the network environment. Middleware layers such as Microsoft's Open Database Connectivity (ODBC) provide a standard way to link programs with databases. ODBC is seeing new uses in linking corporate intranet sites to corporate databases. Microsoft and IBM have suites of network management, software distribution, e-mail, mainframe access, and other applications aimed at providing the same environmental invisibility in many areas. Setup, graphical, and computational information regularly flows between programs in these environments.


THE NETWORK ENVIRONMENT
Application program
Network application services
A network-aware application sees a wide range of places from which to request services, including the operating system and special services for program-to-program communications. These program services in turn negotiate with network transport services, such as IPX and IP, to move data across the physical network.
IPX
SERVICE LAYER
RPC API
Disk OS
Messaging API
Database API
IPX
IP
TRANSPORT LAYER
RPC API
Disk OS
Application program
OBJECT REQUEST
RESULT
Remote-procedure call (RPC)
Using a remote-procedure-call standard, such as Microsoft's ActiveX or the Common Object Request Broker Architecture (CORBA), a client can access information on a variety of network resources. The application on the above PC is using an RPC to request information and exchange data with other programs.
Client/server systems
In a client/server system, the client uses a database API to query a database server. Processing occurs on the server, not the client, so network traffic is much lighter.
Application programming interfaces (APIs)
Programs make use of APIs to call for specific services from the environment. The PC below is using a messaging API to exchange data with e-mail servers, schedulers, and discussion databases.
WIRING HUB
DATABASE QUERY
RESULTS
Application servers
Application servers run specialized network applications such as corporate databases, e-mail post offices, or fax gateways. The applications run on network operating systems—such as Microsoft Windows NT and SCO OpenServer—that can take advantage of RISC processors and multiple CPUs to handle heavy processing loads.
LAN ADAPTER
IP
Application program
Disk OS
Messaging API
IPX
Middleware
A layer of middleware software translates SQL queries from a variety of clients into the dialect of the database engine.
Database engine
The database engine indexes and searches files in response to the client request.
DATABASE ENGINE
APPLICATION SERVER

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THE PERFECT

Departmental LAN

By Frank J. Derfler, Jr. •The client PC is where all networking converges. It is a window into a network of shared resources. The perfect departmental LAN makes this window transparent, so that distant resources look as if they're inside the client PC.

We describe the global view of networking software in "The Perfect Network Operating Environment" in this section. At the desktop PC, the client software consists primarily of redirector and network-transport software. The redirector recognizes an application's request for LAN resources. Essentially, the redirector knows that requests made to the E: drive or LPT2 are intended for a specific network server or printer. The transport programs package the data according to network transport specifications (such as IP or NetWare's IPX) and send the data packets out to the LAN adapter.

LAN adapters translate the low-power parallel data inside the computer into a higher-power serial stream for external connectivity. The LAN adapters must be compatible with the network cabling, the PC's internal data bus, and the network operating system. Fortunately, standards such as Ethernet and Token-Ring for signaling and access across the cable, ODI (emulated by Microsoft's NDIS) for operating system interfaces, and PCI for the PC's bus let you choose adapters from many manufacturers. IBM, Motorola, 3Com, and Xircom offer PC Cards (formerly PCMCIA cards) that combine a LAN adapter with a modem.

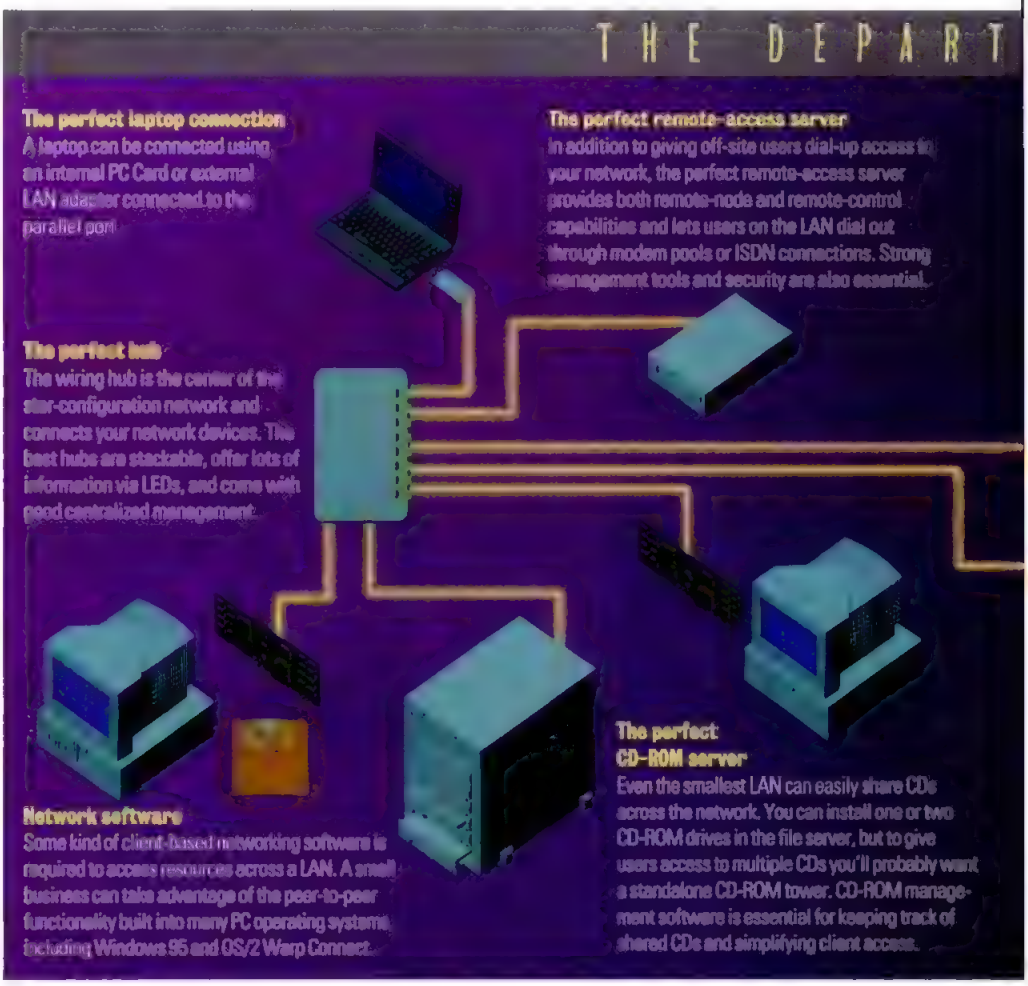
The perfect LAN blends two network cabling technologies: unshielded twisted-pair (UTP) and fiber-optic cable. Installing UTP cable meeting the EIA Category 5 specification, along with such other Category 5 equipment as connectors and patch panels, gives you a cable infrastructure that should last for at least a decade. A Category 5 UTP system can carry the fastest practical signaling in use today—ATM at 155 Mbps—over distances of about 100 feet. For longer distances or in noisy electrical environments, you can augment the UTP with fiber-optic cable. Fiber-optic components are still expensive, however, so you'll want to use UTP to the desktop in practically every environment.

WIRED WORKGROUPS

The perfect workgroup uses network adapters that can operate using either standard 10-Mbps Ethernet (10Base-T) or 100-Mbps Fast Ethernet (100Base-T) as applications drive the need for faster signaling. These adapters—called 10/100 adapters—serve as affordable insurance against technological surprise. Also, if you're running at 100 Mbps, your desktop PCs and servers should use PCI-bus adapters.

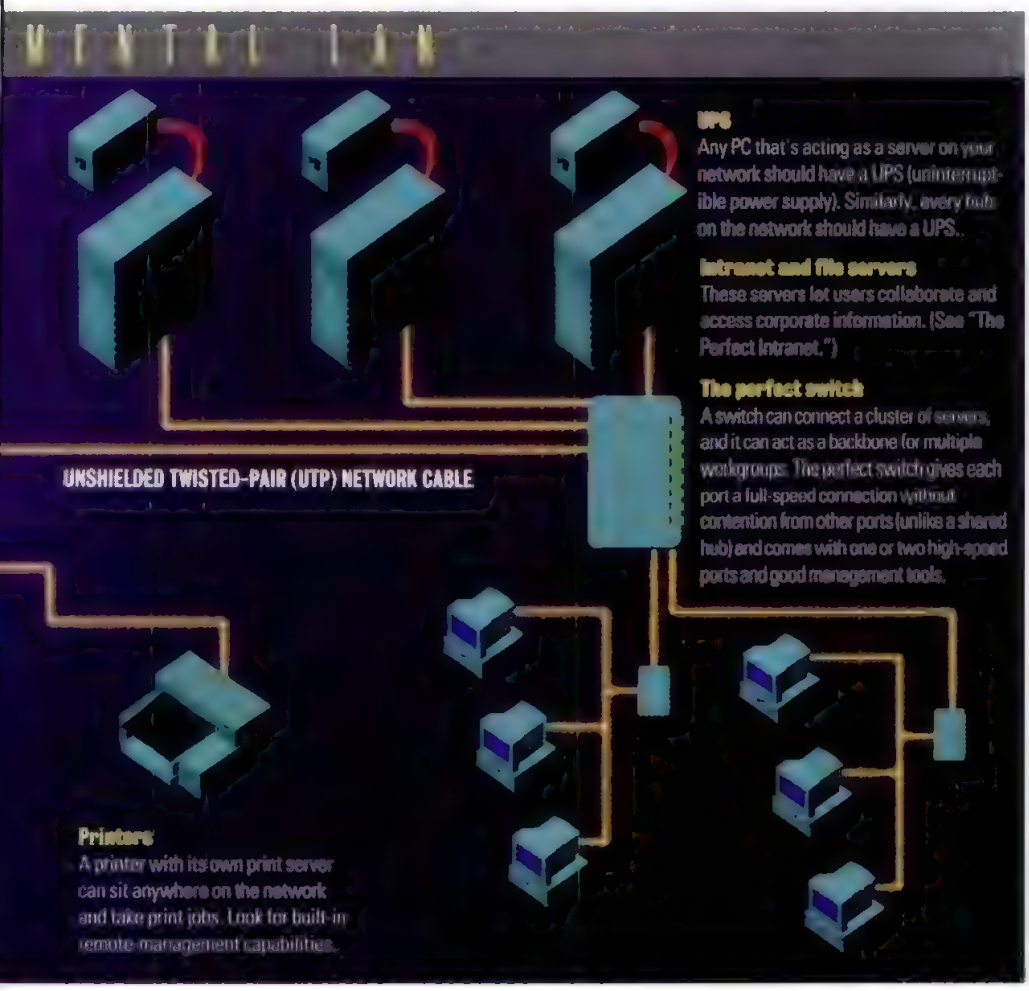
A network hub is at the geographical center of the workgroup LAN. A hub provides electrical isolation for the cable runs to each node so that a short on one cable doesn't take down the entire LAN. You need a hub port for each node, including PCs, printers, access servers, and other specialized devices.

Stackable hubs, the hottest products in this category, are separate modules



that nest together with a high-speed interconnection. Electrically, the interconnected stack looks like one entity on the LAN, so the stack doesn't violate rules about the number of repeating devices that can pass signals on a network segment. Financially, stackables present an easy way to expand capacity and features in affordable steps. Network segmentation is an important consideration in designing the perfect LAN. You can reduce contention for access to the cable and overall LAN traffic by breaking the LAN into logical pieces connected by a smart device. If you're using a NetWare file server, it's easy and practical to segment the LAN by putting more than one LAN adapter in the file server. NetWare has an internal router that can move traffic between segments while reducing the competition for access. In case you're not using NetWare, you can install a separate internal router for LAN segments that have a lot of internal traffic.

Switching is the latest technique for reducing LAN congestion. A switch routes packets of data between nodes on the LAN. Each switched segment has uncontended cable access and sees only traffic destined for its segment. Switches from Asanté, Bay Networks, Cisco, Digital, 3Com, and others are easy to add to a network: Installation consists of plugging in a few cables. You can replace a hub with a switch, add a switch to a stackable hub, or use a switch as a backbone to connect groups of hubs. As our diagram shows, a switch is an excellent traffic director between workgroup LAN hubs and busy file servers. For the best data path, you'll want a switch with a dedicated 100-Mbps server connection.



OTHER NETWORK SERVICES

Networked printers and remote-access servers are important elements of the departmental LAN. Each networked printer takes print jobs from individual PCs or from print servers, often servicing both IP and IPX requests. Network printers have to connect only to a LAN cable and AC power, so you can place them in convenient spots throughout the department. (For a review of network printers, see "Share and Share A Lot," June 11, 1996.)

Remote-access service breaks down into remote node and remote control. Remote-control software—such as that from Artisoft, Avalan, Microcom, Symantec, Traveling Software, and others—lets you remotely operate a PC and is useful because it keeps important data on the LAN. Remote-node connections allow the same type of operation on the road as in the office but with some practical limitations on what you can pull across the dial-up link.

Remote-node servers are routers. Products from companies such as Ascend, Cisco, Microcom, Shiva, and 3Com can connect through analog modems or ISDN devices. In addition to dial-in connections, they also provide shared dial-out service.

A departmental intranet server may provide an ideal medium for sharing information on the LAN, especially if you have multiple operating systems on the network. See "The Perfect Intranet" in this section.

THE PERFECT Intranet

By Frank J. Derfler, Jr. • Intranets, which use Internet technology inside the corporate network, sound deceptively simple. But their capabilities will surprise you. Intranet Web servers can scale from individual departments to worldwide enterprises. You'll start out using them to publish information such as telephone directories, but you'll find that they can be the basis of group discussion systems and the salvation of older mainframe-based applications. (For a review of intranet systems, see "The Web Within," April 23, 1996.)

The ubiquitous, inexpensive Web browser makes intranets practical. You can find browsers for practically every hardware and operating system platform. Instead of worrying about installing client packages for proprietary publishing, scheduling, and discussion systems, network managers need only consider how to connect users to their intranet Web servers.

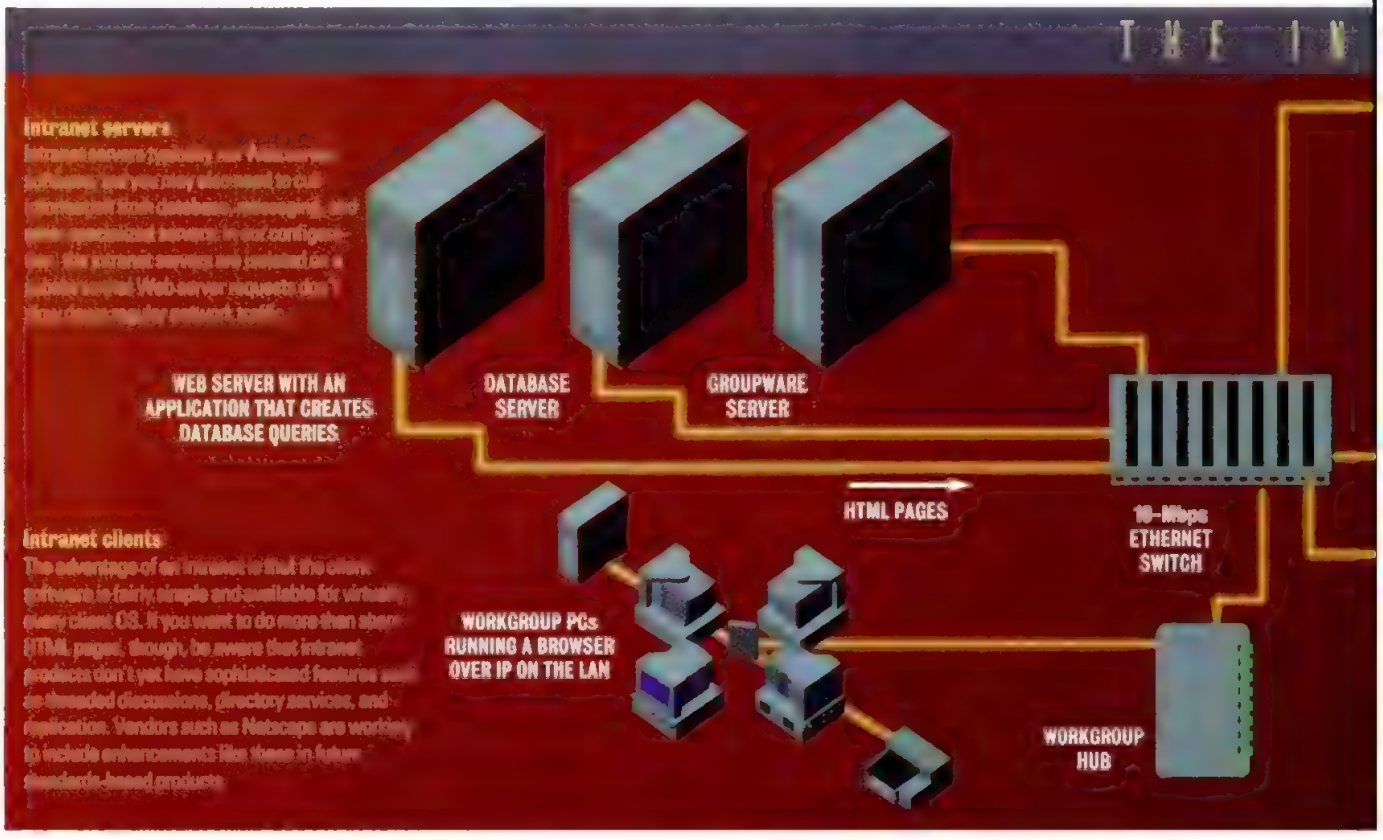
Generally, Web servers are affordable and not difficult to run. An intranet server can be as simple as a Pentium-class computer equipped with 32MB of RAM, a CD-ROM, a LAN adapter, and Windows NT Server—for a total cost of less than $3,800. This kind of system can satisfy thousands of page requests a day, but it might suffer slowdowns during peak request times. Adding a faster disk access subsystem would improve its capacity.

The hidden cost of Internet and intranet technology may jump out at you if you have to add TCP/IP protocols to your LAN and corporate PCs. Adopting TCP/IP on your corporate network creates significant equipment, training, and management burdens. PCs need more RAM; you might have to reconfigure and update routers; and the specter of outsider intrusion raises its head. As an alternative to NetWare networks, you can use IPX-to-IP gateways, such as those from Firefox Communications, Performance Technology, and Quarterdeck, to avoid having to add IP to every desktop PC.

REMOTE POSSIBILITIES

A solid remote-access strategy is critical to the success of an intranet. The nature of the browser and IP relationship dictates remote-node access service for dial-in callers. We suggest remote-access routers that connect over both fast modems and ISDN adapters, protected with passwords and security servers.

Most users will access intranet servers across the corporate WAN. If your intranet system is successful, you might incur a secondary cost in reconfiguring your LAN to accommodate a busy Web server. As our diagram shows, you can create a subnet behind a switch with the Web server, information database server, and remote-access server each having a dedicated segment on the switch. This keeps intranet traffic off the cables carry-



ing your network's bread-and-butter data.

The person in charge of the intranet system needs practically the same skills as the administrator of a small LAN, plus some rudimentary graphic-arts skills and the ability to handle both TCP/IP and HTML. You can find useful HTML editing tools on the Web, and even desktop application suites such as Microsoft Office and have HTML editing features. As an intranet grows, skills like database administration, advanced graphic arts, and telecommunications management quickly come into play.

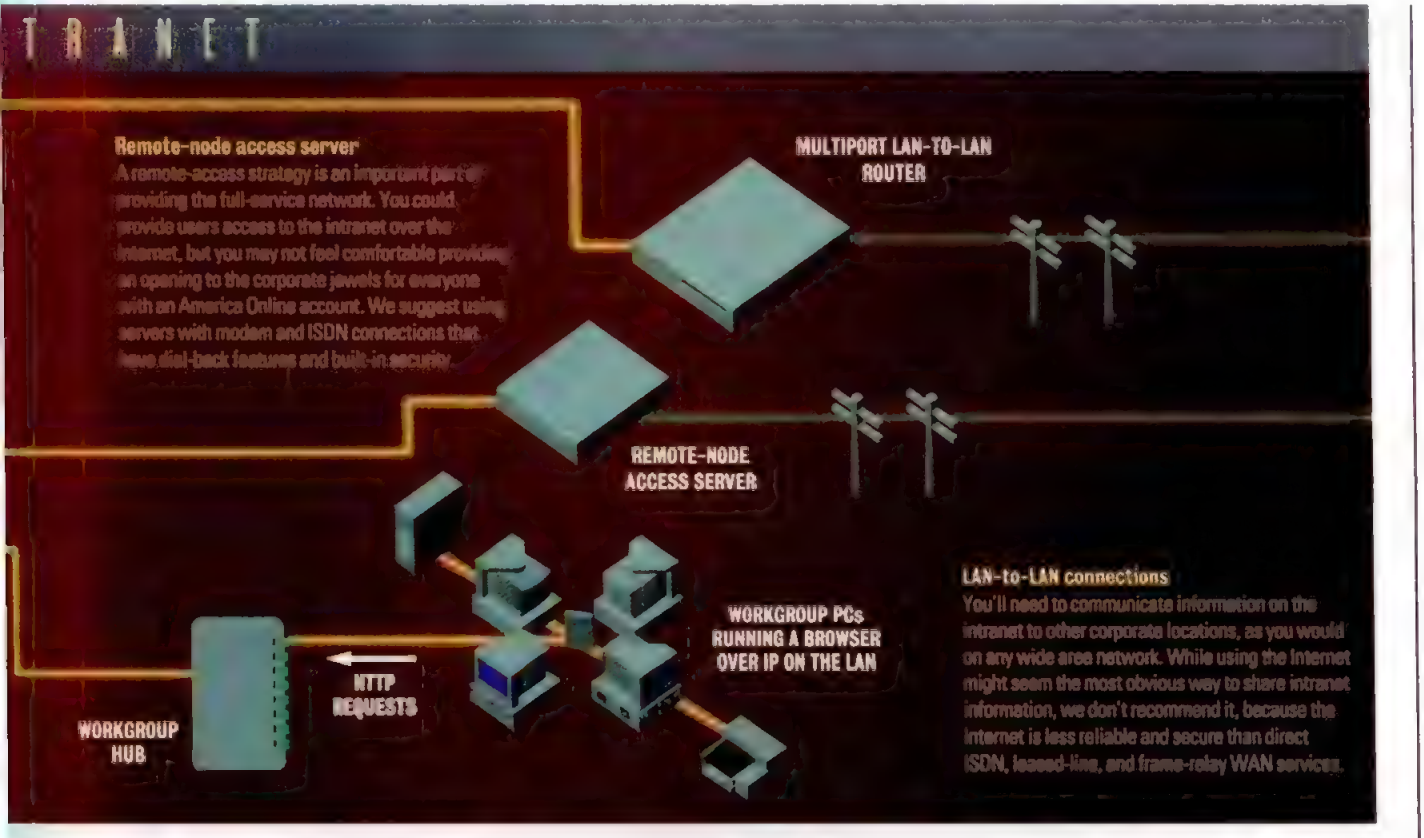
While it's easy to start an intranet, its complexity can grow quickly. Web server software recognizes HTTP requests from browsers and does something in response. The typical response is to transmit an HTML-encoded page back to the client. But the server can also pass requests on to other layers of software or even to other servers on the LAN for action. That handoff between the Web server and other functions is critical, because it opens the door to such capabilities as sophisticated e-mail and database services that make an intranet competitive with established groupware products.

A standard called the Common Gateway Interface (CGI) allows browser requests to kick off a user-written program that can generate a query to a database. The CGI program then formats the response to the query into HTML and sends it back to the Web server, which sends it back to the browser. CGI programming isn't for novices, but Oracle and Sybase each provide information at their Web sites on how it's done. Microsoft offers a layer of Windows NT Server software—called the Internet Database Connector—that translates between HTTP and products that conform to the Open Database Control standard.

Intranets are challenging, and working with, established proprietary document database, workgroup discussion, e-mail, and scheduling applications such as Novell's GroupWise and Lotus Notes. Digital Equipment Corp. has a big stake in the market with its impressive Workgroup Web family of intranet group discussion products. Similarly, Folio Corp.'s Infobase Web Server provides a slick way to get at documents that are stored in Folio's proprietary database structure.

Last year, Netscape acquired Collabra Software and its premier threaded-discussion system. With the promised capability to integrate hypertext links within a threaded discussion system, the Netscape Web server and browser are an obvious choice for an intranet solution. But Lotus is keeping up: The Lotus InterNotes server links HTTP servers to Notes document databases. Notes also offers replication, a capability that is in its infancy on the Web.

We can expect products that combine browsers with a wide variety of common applications and utilities from Attachmate, Digital, Lotus, Microsoft, Netscape, Novell, Quarterdeck, and others.



THE PERFECT

Small Office Connections

By Frank J. Derfler, Jr. • Small offices typically have small budgets for such overhead items as networking and communications. Our goal for the perfectly connected small office is to make it work like a large corporate office while holding down costs.

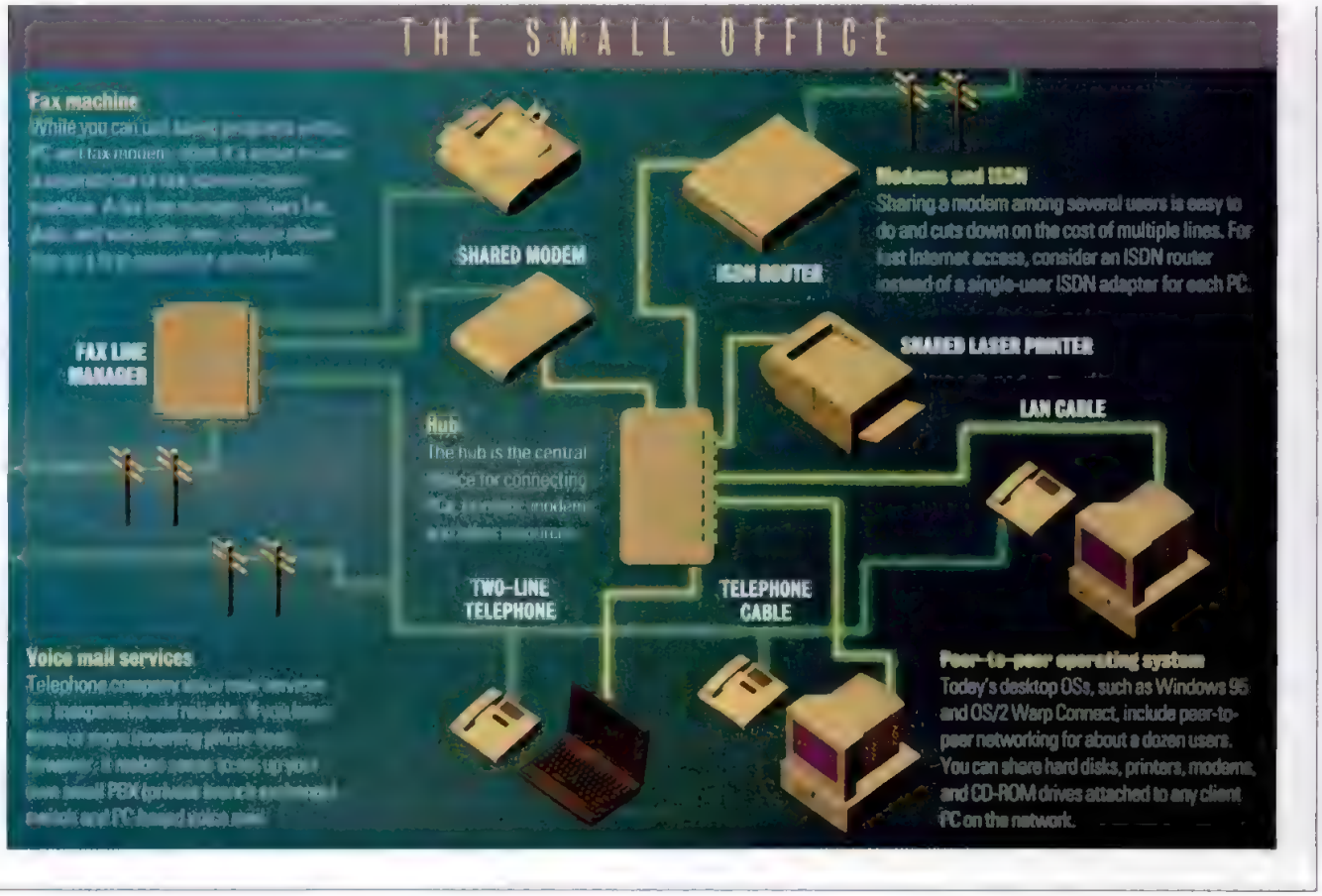
Our plan starts with a LAN. Even for those who have only two PCs, a LAN connection provides the fastest and most reliable way to share hard drives, CD-ROM drives, modems, printers, and other resources. Microsoft's Windows family of products are probably the most convenient network operating systems. Peer-to-peer networking—sharing resources among PCs on the network instead of using dedicated server systems—is built into Windows for Workgroups, Windows 95, and Windows NT Workstation. OS/2 Warp Connect provides similar networking capability, and Artisoft's LANtastic family adds some more-advanced features to a peer-to-peer network. Companies such as Asanté Technologies, D-Link, and Linksys sell tiny hubs that can stick to the back of a desk, so the cabling is out of the way.

For fast Internet access, even on a three- or four-node LAN, we suggest using an ISDN router instead of individual ISDN adapters. A router can be centrally managed, and splitting the cost of a single line for several users makes sense. You will probably need to get a static IP address from your Internet service provider, but the benefits outweigh the hassle. We also suggest sharing a modem for outbound analog calls. Shared modems are easy to set up, and they save money.

While you can integrate fax capabilities inside a PC, it's hard to match the convenience of a separate fax machine or a combination fax/scanner/printer. Similarly, we suggest subscribing to voice mail from the local telephone company instead of setting up an answering machine. These services typically cost only about $20 a month, and your callers never get a busy signal.

A simple device called a fax line manager allows a fax machine, a modem, and a telephone to share a single telephone line on a first-come-first-served basis. You can set it up to recognize different types of incoming calls and route them to the appropriate device. We suggest using the fax/modem line as an outgoing voice line when it isn't otherwise in use.

Two incoming lines can satisfy an office of three or four workers. When you add a third or fourth incoming line, though, you should consider a small PBX (private branch exchange) switch and a PC-based voice mail and interactive voice response (IVR) system. A PC-based IVR system can provide voice mail as well as more sophisticated menus to callers. □



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2	7.70			

BUSINESS WEEK CONFIRMS WHAT YOU ALREADY KNEW.

In search of the perfect PC? Just ask *Business Week*. In its First Annual Computer Buying Guide, the Dell Dimension XPS P133c was rated #1 among the "Best Bets for PC Buyers."* That's another best for Dell, a company famous for delivering the best performance, the best features, the best value. But that's probably not news to you, is it?

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Readers Rate SERVICE & RELIABILITY

By Rachel Derby Teitler and Mary E. Behr • The freedom to choose can be both a blessing and a curse. Buying a PC today is a textbook example of this paradox. In every mainstream PC roundup that we conduct at *PC Magazine*, we're faced with seemingly endless choices. While there are significant differences among the dozens of machines that we review in terms of levels of performance, features offered, and price, there are still many that appear to be equal on this competitive playing field.

This is why we conduct our annual survey of service and reliability. Although the PC market is a maturing market, it's far from a commodity market. A major differential for vendors today remains the quality of service and support they provide, and the reliability of the machines they sell. The key question is: How well will a vendor serve you when you really need help?

With this in mind, we present the results of our seventh Service and Reliability survey. In March of this year, we mailed surveys to 17,000 of our subscribers, asking them for their opinions on the quality of service and technical support that they've received from PC vendors in the past two years. We also asked them to report the number of times they've had their PCs repaired in the past year, so that we can provide a measure of overall product reliability. For this survey, we received responses from more than 8,500 of our subscribers. These responses rate more than 16,000 desktop PCs from 31 vendors and nearly 4,000 notebooks from 19 vendors.

SURVEY SAYS . . .

We asked survey respondents 14 questions each for desktops and notebooks, but only 4 of these questions count toward a vendor's grade on our Readers' Report Card. Three of these questions are long-standing measures that we've been using to gauge subscribers' satisfaction with PC vendors since we began conducting this survey in February of 1993:

- satisfaction with reliability,
- satisfaction with repair experiences,
- satisfaction with technical support.

In our last survey, we added a fourth key measure to our grading scheme to judge overall product reliability: We asked how many times a PC needed repairs in its *first* 12 months of use. We've slightly retooled the question for this survey to ask how many times a PC needed repairs in the *past* 12 months. We feel that this rewording more accurately portrays recent experiences. (To avoid confusion on the two repair issues, we will refer to satisfaction with repair experiences as "repair satisfaction" and the percentage of machines needing repair in the past 12 months as "repair frequency.")

We calculate the Readers' Report Card grades based on these four key measures. As judged by our subscribers, the vendors that receive A's on this survey are:

- **Desktop PC vendors:** Compaq Computer Corp., Dell Computer Corp., Hewlett-Packard Co., IBM Corp.
- **Notebook PC vendors:** Compaq, Toshiba America Informations Systems.

READERS' REPORT CARD

Desktop Vendors

A	Compaq	Hewlett-Packard
	Dell	IBM
B	Apple	NEC
	Digital	Northgate
	Gateway 2000	Tri-Star
	Micron	
C	Acer	DTK
	AST	Epson
	AT&T GIS/NCR	Tandy
	Austin	Wyse
	CompuAdd	ZEOS
D	ALR	Leading Edge
	Compudyne	MidWest Micro
	Everex	Packard Bell
	Hyundai	Unisys
	Insight Direct	Zenith Data Systems

HOW TO MAKE THE GRADE

Each vendor represented in our survey is given a letter grade of A, B, C, D, or E, based on the ratings they receive from our subscribers on the four key survey measures. These grades are set forth on our Readers' Report Cards. Here's how the grades are calculated.

- **A:** The vendor receives significantly better-than-average scores on all four key survey measures: satisfaction with reliability, repair experience, and technical support, and the percentage of machines that needed repairs in the past 12 months.
- **B:** The vendor receives a combination of significantly better-than-average and average scores on the four measures.
- **C:** The vendor is average on all four measures or receives a combination of better-than-average and

worse-than-average scores.

- **D:** The vendor is worse than average on some key measures and average on the others.
- **E:** The vendor is worse than average on all four key measures.

The report-card grades will also appear in every *PC Magazine* desktop and notebook review for the next year.

SIGNIFICANT FINDINGS

One of the more notable results this year is that Dell is the first exclusively mail-order vendor to receive better-than-average scores on all four key survey measures, resulting in its report-card grade of A. This marks Dell's return to the top ranks since we added a question about repair frequency one year ago (on that survey, Dell received a grade of B; the vendor had previously earned an A on each of five consecutive surveys).

READERS' REPORT CARD

Notebook Vendors

A	Compaq	Toshiba
B	Apple Dell Gateway 2000	Hewlett-Packard IBM NEC
C	Acer AT&T GIS/NCR Digital	Tandy WinBook
D	AST Epson MidWest Micro	Texas Instruments Zenith Data Systems ZEOS

We also found that the bar has been raised on how low is low. While there are six vendors that receive A's, no vendor receives a grade of E this year, in either the desktop or the notebook category. The lone E vendor of last year (CompuAdd Computer Corp., in the notebook category) did not receive the requisite 50 mentions that our statistical researchers require to ensure that the data is valid.

IN GENERAL, USERS ARE HAPPY

Users are generally satisfied with their systems, a conclusion that tracks well with our findings from previous years' surveys. For desktops (on a 10-point scale, with 10 being best) the overall average for satisfaction with reliability is 7.8, satisfaction with technical support is 7.0, and satisfaction with repair experience is 7.3. For notebooks the averages are 7.9, 7.1, and 7.1, respectively.

As for recent repairs, desktops and notebooks have needed repairs equally

HOW WE SURVEYED

Service & Reliability

In February 1996 we mailed questionnaires to a randomly selected sample of 17,000 *PC Magazine* subscribers. The survey was closed for tabulation on April 5, by which time we had received a 50 percent response rate. Willard and Shullman, a research firm based in Greenwich, Connecticut, tabulated the survey.

The survey covered desktop PCs, notebooks, and software applications. The software results may be found in "Readers Rate Support and Satisfaction" later in this issue.

Each subscriber described up to five desktop and notebook PCs used over the past two years, including the one used most often. Then, on a scale of 1 (worst) to 10 (best), respondents rated their satisfaction with PC reliability, repair experience, and technical support received. They also indicated the number of times their PCs needed to be repaired in the past 12 months. The results of these four measures are the determining criteria for our Readers' Report Card grades.

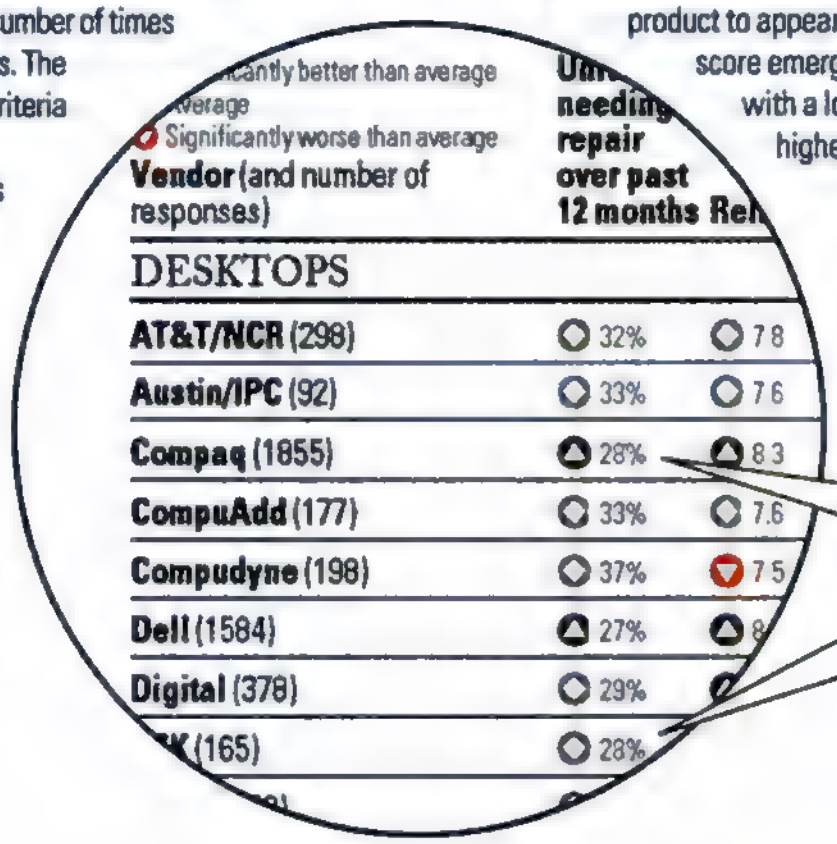
Only vendors that received at least 50 responses —which we considered the minimum amount of data necessary to produce statistically reliable results—were included in the final tabulations.

To analyze the results, we focused on one question at a time and calculated a score (an average of the ratings) for each PC manufacturer. As a standard of comparison, we calculated an overall average for each measure by adding the individual manufacturer ratings and dividing by the number of manufacturers rated.

We report the survey findings in terms of how ratings for each PC manufacturer compare with the overall average. We made these designations using a *t-test*, a standard statistical procedure used to identify differences from the average that are significant at the 95 percent confidence level.

T-tests take into consideration the ratings, the amount of variation among the ratings, and the number of ratings received. These components determine the confidence interval for each score, or the range into which we are 95 percent certain that the score falls. The fewer the ratings and the greater the amount of variation among the ratings, the larger the range will be. Only when the range is entirely above or below the overall average is the vendor's score considered significantly different from the average. Therefore it's possible for one product to appear in the average range while another with the same score emerges as significantly above average, or for a vendor with a lower score to be above average, while one with a higher score is not.—*Rachel Derby Teitler*

▲ Significantly better than average
○ Average
▼ Significantly worse than average



Though two vendors may receive the same numerical score, when t-tested against the average, one may emerge as significantly better or worse than average while the other does not. This can happen because t-tests consider not only the individual ratings but also the number of responses and the amount of variation among them. A larger number of responses or a smaller amount of variation among the ratings increases the likelihood that a given product's score will be significantly different from the average.

Desktop vendors:

Compaq, Dell, Hewlett-Packard, IBM

Notebook vendors:

Compaq, Toshiba

Offering superior service and support is an excellent way for a vendor to differentiate itself from the pack.

The five winners of our Readers' Choice award clearly understand this concept, as they are no strangers to the winners' circle.

All five received better-than-average scores on our four measures of success: satisfaction with reliability, satisfaction with repair experience, satisfaction with technical support, and percentage of units needing repairs in the past 12 months. This last item represents the second time that we have asked a question designed to measure actual product reliability (though it differs from our question last year, when we determined the percentage of units needing repair in the *first* 12 months of use).

The four winners of our Readers' Choice award in the desktop category have each won this award before. Hewlett-Packard Co. receives its fifth consecutive grade of A. For Compaq Computer Corp. and IBM Corp., this survey marks four A's in a row. Dell Computer Corp. also returns to the winners' circle this year. The company receives a better-than-average score on our repair-frequency question to add to its better-than-average scores on our three satisfaction questions.

The notebook division's Readers' Choice winners are no surprise: Compaq and Toshiba America Information Systems. Compaq excels in two categories, receiving its sixth consecutive grade of A for notebooks since July 1993. Toshiba, the clear leader in the notebook marketplace, repeats its A performance of last year.

often in the past 12 months: an average of 32 percent for desktops and 33 percent for notebooks. When a repair is necessary, our survey finds, desktop vendors on the average can help solve the problem over the phone 20 percent of the time. The vendor sends a new part 26 percent of the time, while the dispatch of a repair technician is necessary 29 percent of the time.

We include data from several companies that have significantly scaled back their market presence or are no longer actively marketing PCs, because users still have their systems in service. (Note that this survey covers machines used in the past two years.) Northgate Computers is an example of the latter: It is a lesser force today than it was in the late 1980s, when it was a direct-market pioneer.

Wyse Technology now markets monitors and Windows terminals. CompuAdd is not currently selling or servicing systems. (Capital Data, a third-party service provider, currently provides service for CompuAdd PCs.) Hyundai Electronics America is a player in the monitor market, as well as a minor presence in notebooks. Tandy Corp. no longer manufactures PCs. Epson America, though it still sells notebook PCs, is de-emphasizing North American sales and concentrating instead on its imaging business and on selling systems in Latin America.

Insight Direct no longer sells its own brand of PCs, though it still has a healthy mail-order business selling other brands. And last year, Micron purchased ZEOS International; it phased out the ZEOS brand name early this year. Leading Edge Products is not currently selling PCs.

Several companies that appeared in our survey last year did not receive the minimum 50 responses to be included this year: USA Flex and Wang in the desktop category, and Austin, CompuAdd, and Packard Bell Electronics in the notebook arena.

TOP OF THE DESKTOP CHART

Four desktop vendors received A's from our readers, indicating scores significantly better than average on our four key survey measures. Three of these vendors are veterans: Hewlett-Packard, earning an A for the fifth time in a row, and Compaq and IBM, each making the A list for the fourth straight time. Dell rounds out the winners' circle, back on top from its grade of B in our last study. In the past year, Dell has responded positively to increasing sales—by adding telephone tech-support staff, expanding the level of training it provides for its support technicians, and improving its existing telephone queue system.

GRADE OF B: STILL IMPRESSIVE

Apple Computer, Digital Equipment Corp., Gateway, Micron, NEC Technologies, Northgate, and Tri-Star Computer received a combination of better-than-average and average scores from our subscribers, which for each constitutes a highly respectable grade of B. For Apple, Gateway, Micron, and NEC, this is a repeat performance from our last survey. For Apple, the grade is the same, but the individual scores have changed: The vendor's satisfaction-with-reliability score is now average, while its scores for satisfaction with tech support and repair experience are better than average.

For Northgate and Tri-Star, a B represents an improvement from our last survey. Tri-Star's repair-satisfaction score improved to better than average. The company has recently expanded internal resources available to its telephone tech-support staff. Northgate benefits from our new cast on the actual-repair question; it receives an average score for repair frequency, which replaces its below-average score on our repair-frequency measure.

On each of the three surveys prior to this year's, Digital received a grade of A.

Our Contributors: MARY E. BEHR is a staff editor of *PC Magazine*. RACHEL DERBY TEITLER is the research manager for Ziff-Davis Publishing Co.

What are your chances of losing everything on your computer?

Has your screen ever frozen?

Have you ever lost a file?

Does your screen blink for no reason?

Have you ever had an application quit unexpectedly?

Have you ever been unable to open a file?

Have you ever been unable to save a file?

Have you ever been unable to find a file?

Have you ever had a printing problem?

Have you ever gotten an unintelligible error message?

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CIRCLE 308 ON READER SERVICE CARD

HOW READERS RATED

PC Vendors

○ Significantly better than average
○ Average
○ Significantly worse than average

Vendor (and number of responses)	Units needing repair over past 12 months	Satisfaction with: Reliability	Repair	Tech support	Buy again?
DESKTOP VENDORS					
Acer (485)	○ 31%	○ 7.8	○ 7.2	○ 6.9	▲ 6.6
ALR (110)	○ 33%	○ 7.7	○ 7.1	▼ 6.3	▼ 5.1
Apple (593)	▲ 22%	○ 8.0	▲ 7.7	▲ 7.5	▲ 6.1
AST (612)	○ 31%	○ 7.8	○ 7.4	○ 6.8	○ 5.9
AT&T GIS/NCR (298)	○ 32%	○ 7.8	○ 7.4	○ 7.2	▼ 4.9
Austin (92)	○ 33%	○ 7.6	○ 7.2	○ 7.1	○ 5.8
Compaq (1,855)	▲ 28%	▲ 8.3	▲ 7.7	▲ 7.5	▲ 7.1
CompuAdd (177)	○ 33%	○ 7.6	○ 7.3	○ 7.0	▼ 4.7
Compudyne (198)	○ 37%	▼ 7.5	○ 7.0	▼ 6.4	▼ 5.2
Dell (1,584)	▲ 27%	▲ 8.7	▲ 8.3	▲ 8.0	▲ 8.1
Digital (378)	○ 29%	▲ 8.2	○ 7.6	▲ 7.5	▲ 6.6
DTK (165)	○ 28%	○ 7.7	○ 7.2	○ 6.7	○ 5.3
Epson (142)	○ 26%	○ 7.4	○ 6.8	○ 6.9	○ 5.3
Everex (121)	○ 36%	▼ 7.3	▼ 6.6	▼ 6.0	▼ 4.0
Gateway 2000 (2,662)	○ 31%	▲ 8.6	▲ 8.0	▲ 7.4	▲ 8.1
Hewlett-Packard (608)	▲ 27%	▲ 8.3	▲ 7.8	▲ 7.7	▲ 7.3
Hyundai (58)	○ 24%	○ 7.5	○ 7.2	▼ 6.1	○ 4.9
IBM (2,149)	▲ 28%	▲ 8.1	▲ 7.7	▲ 7.4	▲ 6.6
Insight Direct (74)	▼ 46%	○ 7.8	○ 7.2	○ 6.7	○ 5.7
Leading Edge (206)	○ 35%	▼ 7.3	▼ 6.5	▼ 5.5	▼ 4.4
Micron (581)	○ 31%	▲ 8.9	▲ 8.5	▲ 8.1	▲ 8.8
MidWest Micro (142)	▼ 47%	○ 8.0	○ 7.4	○ 7.0	▲ 6.6
NEC (339)	▲ 26%	○ 7.9	○ 7.4	○ 7.2	▲ 6.5
Northgate (114)	○ 29%	○ 8.0	○ 7.6	▲ 7.9	▼ 4.3
Packard Bell (1,305)	○ 32%	▼ 7.6	▼ 6.7	▼ 6.4	▲ 6.0
Tandy (195)	▲ 25%	▼ 6.9	○ 6.8	○ 6.5	▼ 3.5

○ Significantly better than average
○ Average
○ Significantly worse than average

Vendor (and number of responses)	Units needing repair over past 12 months	Satisfaction with: Reliability	Repair	Tech support	Buy again?
Tri-Star (54)	○ 43%	○ 8.0	▲ 8.0	○ 7.6	▲ 7.1
Unisys (109)	○ 30%	▼ 7.1	○ 7.0	○ 6.9	▼ 4.2
Wyse (56)	○ 38%	○ 7.3	○ 7.2	○ 7.2	▼ 4.0
Zenith Data Systems (278)	○ 33%	▼ 7.2	▼ 6.9	▼ 6.3	▼ 4.3
ZEOS (501)	▼ 37%	▲ 8.2	○ 7.4	○ 7.0	○ 6.1
AVERAGE	**32%**	**7.8**	**7.3**	**7.0**	**5.8**
NOTEBOOK VENDORS					
Acer (74)	○ 24%	○ 7.5	○ 6.4	○ 6.0	○ 5.9
Apple (132)	▲ 25%	○ 8.1	○ 7.3	○ 7.5	○ 6.4
AST (167)	○ 39%	▼ 7.4	○ 6.5	○ 6.7	○ 6.2
AT&T GIS/NCR (74)	○ 36%	○ 7.7	○ 7.4	○ 7.5	○ 5.9
Compaq (633)	▲ 29%	▲ 8.3	▲ 7.7	▲ 7.7	▲ 7.5
Dell (245)	○ 31%	▲ 8.2	○ 7.3	○ 7.5	▲ 7.5
Digital (59)	○ 36%	○ 7.9	○ 7.0	○ 7.1	○ 6.4
Epson (51)	○ 35%	▼ 7.0	○ 5.9	▼ 5.9	○ 5.8
Gateway 2000 (244)	○ 29%	○ 8.0	○ 7.4	▲ 7.5	▲ 7.4
Hewlett-Packard (78)	○ 33%	○ 8.2	▲ 8.0	▲ 8.4	▲ 7.8
IBM (711)	○ 31%	▲ 8.5	▲ 8.0	▲ 7.9	▲ 7.9
MidWest Micro (54)	▼ 52%	○ 7.3	○ 5.9	▼ 5.6	○ 5.8
NEC (213)	○ 31%	▲ 8.4	▲ 7.8	▲ 7.5	▲ 7.3
Tandy (51)	○ 27%	○ 7.8	○ 7.4	○ 6.6	▼ 4.3
Texas Instruments (137)	▼ 46%	○ 7.8	○ 7.4	○ 7.3	○ 6.9
Toshiba (730)	▲ 24%	▲ 8.7	▲ 7.7	▲ 7.7	▲ 8.2
WinBook (118)	○ 42%	○ 8.1	○ 7.3	○ 7.4	▲ 7.7
Zenith Data Systems (149)	○ 27%	▼ 7.3	▼ 6.0	○ 6.6	▼ 5.1
ZEOS (60)	○ 32%	▼ 7.0	○ 5.8	▼ 5.6	▼ 5.0
AVERAGE	**33%**	**7.9**	**7.1**	**7.1**	**6.6**

This year, however, the vendor's scores in two categories have changed: Satisfaction with repair experience dropped to average, and the recent-repair score is average. The company says that it has beefed up its telephone tech-support staff; indeed, Digital's satisfaction-with-technical-support score remains at the significantly better-than-average level.

MIDDLE OF THE ROAD

In the middle, and recipients of C's, are Acer America Corp., AST Research, AT&T GIS/NCR, Austin, CompuAdd, DTK Computer, Epson, Tandy, Wyse, and ZEOS. Except for Tandy and ZEOS, each qualifies for a C with average scores on all four key measures.

Six of the ten entries in this category (AT&T, Austin, CompuAdd, Epson, Tandy, and Wyse) have improved since our last survey, on which they received D's. AT&T, Epson, and Wyse have improved because their satisfaction-with-reliability scores rose to average. Epson also shows comparable improvement in the area of satisfaction with technical support. For both Austin and CompuAdd, the improved grade comes as a result of average scores for repair frequency, which replace last year's worse-than-average first-year-repair scores. Tandy's satisfaction-with-repair-experience and satisfaction-with-tech-support scores rise to average, and the company's repair-frequency mark is better than average.

AT&T GIS is now operating under its previous name, NCR, and will become an independent, publicly owned company in 1997. AT&T's and NCR's scores are combined into one grouping in this story, listed as AT&T GIS/NCR. Over the past year, NCR focused on increasing its telephone tech-support personnel, as well as bolstering its remote-support offerings.

AST previously received a grade of B but drops to a C as a result of its satisfaction-with-reliability and satisfaction-with-repair-experience marks; both have fallen to average. This comes despite a 40 percent personnel increase in its telephone tech-support facility, as well as its move to outsource some tech-support calls during peak calling times.

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or

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or

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or

3.5" floppy drive

MODULAR BAY #1:

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Powerful desktop computing, built for the road.

The Micron Millennia TransPort gives you the right combination of performance, standard features and options to match the best of desktop PCs. With award-winning Micron reliability and battery life among the best in the industry, it's a no-compromise PC for the office or the road.

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Micron's exclusive FlexOpt™ dual-bay modular design lets you mix and match devices for a variety of customized choices. Drop in a modular quad speed CD ROM drive. Add a second intelligent modular lithium-ion battery or a second 1.2GB hard drive to boost productivity. And count on built-in flexibility like Micron's innovative Pick-a-Point™ system that lets you choose either touchpad or pointing stick operation.

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A 133MHz mobile Intel Pentium® processor plus pipelined burst cache and EDO memory give you the power you need to take your show on the road at record speed.

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Micron is so confident in the design and construction of the Millennia TransPort that we offer an industry first—the Micron Power℠ warranty*. It includes a five-year limited warranty on the microprocessor and main memory and a three-year limited parts-only system warranty.

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"Replace your desktop PC and your notebook with the Millennia TransPort? It just might be an even trade." —*Windows Sources*, April 1996

"By all accounts . . . a dead-ringer for IBM's ThinkPad . . . but performs better and saves you about $2,500." —*PC Magazine*, April 9, 1996

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"The Millennia TransPort, a bench-burner of a notebook . . . delivered the highest Winstone 96 score we've ever seen on a notebook: 53.3." —*Windows Sources*, April 1996

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- Nylon carrying case
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- Microsoft Office Pro 95 and Bookshelf 95 CDs
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B • 32MB EDO memory (48MB max.)
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- 11.3" active matrix color display
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TRNS-PCMG-96

VENDOR GRADES

Past and Present

	July 1996*	July 1995*	January 10, 1995	July 1994	January 11, 1994	July 1993
DESKTOP VENDORS						
Acer	C	C	B	C	D	D
ALR	D	B	D	C	E	C
Apple	B	B	B	B	B	C
AST	C	B	C	C	B	B
AT&T GIS/NCR	C	D	B	E/C**	E/C**	E/C**
Austin	C	D	C	B	B	A
Compaq	A	A	A	A	B	A
CompuAdd	C	D	B	C	C	A
Compudyne	D	C	C	C	C	C
Dell	A	B	A	A	A	A
Digital	B	A	A	A	B	B
DTK	C	C	C	C	D	C
Epson	C	D	D	E	D	C
Everex	D	D	D	D	C	C
Gateway 2000	B	B	A	A	A	A
Hewlett-Packard	A	A	A	A	A	B
Hyundai	D	D	E	E	E	D
IBM	A	A	A	A	B	B
Insight Direct	D	B	B	B	N/A	N/A
Leading Edge	D	D	D	E	E	E
Micron	B	B	A	A	B	N/A
MidWest Micro	D	B	C	N/A	N/A	N/A
NEC	B	B	C	C	D	B
Northgate	B	C	A	A	B	A
Packard Bell	D	C	E	E	E	E
Tandy	C	D	E	E	E	E
Tri-Star	B	C	N/A	A	C	B
Unisys	D	D	D	C	C	D
Wyse	C	D	E	E	D	E
Zenith Data Systems	D	D	E	E	E	E
ZEOS	C	C	A	A	A	A
NOTEBOOK VENDORS						
Acer	C	N/A	C	B	N/A	N/A
Apple	B	C	A	A	A	B
AST	D	D	D	D	D	B
AT&T GIS/NCR	C	C	B	N/A	N/A	N/A
Compaq	A	A	A	A	A	A
Dell	B	C	D	C	B	A
Digital	C	C	C	B	B	N/A
Epson	D	C	C	C	C	D
Gateway 2000	B	B	A	B	A	C
Hewlett-Packard	B	B	A	B	N/A	N/A
IBM	B	B	A	A	B	A
MidWest Micro	D	D	N/A	N/A	N/A	N/A
NEC	B	B	B	B	D	D
Tandy	C	C	D	C	C	D
Texas Instruments	D	C	A	A	C	C
Toshiba	A	A	B	B	B	A
WinBook	C	N/A	N/A	N/A	N/A	N/A
Zenith Data Systems	D	D	E	E	E	E
ZEOS	D	C	D	B	C	A

*These grades are based on a methodology different from previous surveys. **AT&T GIS now includes NCR. These companies appeared separately in previous surveys.
N/A—Not applicable: The vendor did not receive the minimum 50 responses needed for inclusion in this survey.

TRAILING THE PACK

No vendor receives a grade of E on this survey, so those companies that earn D's represent the poorest performers in this year's survey. Vendors that garner a combination of average and worse-than-average scores are ALR, Compudyne, Everex Systems, Hyundai, Insight Direct, Leading Edge, MidWest Micro, Packard Bell, Unisys Corp., and Zenith Data Systems. Of these ten, five received D's in the 1995 survey: Everex, Hyundai, Leading Edge, Unisys, and ZDS.

Each of the remaining vendors' grades has dropped relative to our last study, with three of them—ALR's, Insight's, and MidWest Micro's—tumbling two grade levels. For Compudyne, the drop stems from scores for satisfaction with reliability and tech support falling to worse than average. For Insight, scores for both satisfaction with reliability and satisfaction with repair experience fall to average, and the repair-frequency score is worse than average. (Note, however, that Insight no longer builds and sells its own PCs; instead, the vendor now resells other brands.) ALR's grade drops, because its satisfaction-with-technical-support score has sunk to worse than average; the vendor's repair-frequency score is average.

MidWest Micro's grade of D is a result of its satisfaction-with-reliability score falling to average; its repair-frequency score is worse than average, which also contributed to this low grade. The vendor says it has implemented a task force to deal with quality issues prior to shipments, increased telephone tech-support staff, and added an online troubleshooting section to its Web site.

Finally, Packard Bell has lost ground, with a fall to worse than average for satisfaction with reliability. Over the past year, Packard Bell has been focusing on compliance with an internal rule requiring that all technicians pass what it calls an "A+ certification test." According to John Hlavac, vice president of international service and support, this decision resulted in the company's loss of 200 people who did not pass the certification test during the peak month of January.

TOP-RATED NOTEBOOK VENDORS

Notebook vendors' grades are marked by a great deal of stability. Of the 19 vendors covered, only 5 now receive grades that differ from those received in 1995. Compaq and Toshiba continue to earn better-than-average scores on all four key measures, resulting in grades of A

REPAIRS AND TECHNICAL SUPPORT

Desktop PC Vendors

		REPAIR EXPERIENCE (among those needing repairs)					TECH-SUPPORT EXPERIENCE (among those with tech-support experiences)				
▲ Significantly better than average ○ Average ▼ Significantly worse than average	Time on hold (minutes)	Problem solved over phone	Sent new part	Fixed on-site	PC was sent out for repair	Got a new PC	Got a run-around	Tech was knowl-edgeable	Tech tried everything to help	Prompt resolution	More than one call to resolve
Acer	○ 15.8	26%	28%	23%	30%	6%	18%	39%	31%	34%	32%
ALR	○ 10.8	17%	22%	33%	33%	N/A	21%	36%	18%	18%	46%
Apple	▲ 8.6	27%	17%	33%	17%	2%	13%	46%	35%	34%	26%
AST	○ 16.9	19%	24%	37%	23%	6%	22%	42%	25%	32%	34%
AT&T GIS/NCR	○ 10.6	15%	32%	41%	12%	9%	18%	46%	37%	24%	34%
Austin	○ 11.6	10%	27%	27%	43%	3%	17%	45%	10%	28%	55%
Compaq	○ 13.3	22%	28%	38%	18%	5%	16%	47%	35%	34%	32%
CompuAdd	○ 15.3	10%	26%	34%	24%	5%	20%	31%	26%	26%	43%
Compudyne	○ 13.3	8%	16%	15%	51%	4%	24%	41%	28%	21%	47%
Dell	○ 12.7	27%	37%	39%	8%	3%	13%	53%	39%	40%	31%
Digital	○ 14.1	17%	17%	45%	14%	6%	18%	45%	41%	34%	34%
DTK	▲ 7.4	15%	17%	32%	32%	4%	9%	50%	25%	38%	19%
Epson	○ 19.8	22%	14%	41%	19%	8%	20%	28%	20%	24%	28%
Everex	▲ 8.7	18%	18%	36%	18%	7%	16%	48%	20%	12%	24%
Gateway 2000	▼ 16.5	36%	50%	13%	11%	2%	17%	49%	43%	36%	40%
Hewlett-Packard	○ 13.6	24%	21%	41%	18%	5%	16%	42%	39%	33%	26%
Hyundai	○ 16.3	7%	36%	21%	50%	N/A	23%	46%	23%	23%	46%
IBM	○ 14.1	20%	26%	39%	19%	5%	18%	42%	36%	35%	30%
Insight Direct	▲ 9.3	24%	44%	12%	29%	N/A	10%	42%	39%	16%	29%
Leading Edge	○ 11.9	10%	14%	17%	33%	6%	28%	23%	23%	19%	45%
Micron	▼ 19.2	32%	51%	17%	8%	4%	12%	54%	43%	45%	27%
MidWest Micro	○ 14.5	33%	42%	13%	25%	3%	26%	52%	40%	31%	27%
NEC	○ 15.9	26%	22%	29%	21%	10%	20%	38%	37%	32%	34%
Northgate	▲ 10.1	15%	33%	21%	27%	3%	7%	59%	38%	45%	24%
Packard Bell	▼ 20.9	26%	17%	24%	28%	7%	26%	40%	37%	30%	41%
Tandy	○ 12.4	19%	10%	13%	46%	2%	35%	24%	24%	19%	43%
Tri-Star	○ 17.6	35%	26%	9%	30%	4%	14%	59%	45%	41%	28%
Unisys	○ 12.7	9%	12%	64%	18%	3%	7%	32%	25%	32%	39%
Wyse	○ 13.7	14%	24%	38%	14%	10%	18%	64%	55%	36%	9%
Zenith Data Systems	○ 9.7	13%	24%	35%	27%	7%	25%	42%	27%	20%	30%
ZEOS	▼ 16.6	34%	43%	8%	20%	6%	21%	44%	37%	29%	44%
AVERAGE	**13.7**	**20%**	**26%**	**29%**	**25%**	**5%**	**18%**	**44%**	**32%**	**30%**	**34%**

N/A—Not applicable: There were no responses for this question.

for both. These two vendors also received A's from our subscribers on our last survey.

Compaq increased its telephone technical-support staff by about 20 percent over the past year and emphasized offerings on its fax-on-request service and electronic help boards. Toshiba says that it has experienced a 20 percent increase in notebook sales for 1995 and correspondingly increased its telephone tech-support staff by nearly 58 percent.

SIX B'S

With combinations of better-than-average and average scores, Apple, Dell, Gateway, Hewlett-Packard, IBM, and NEC all receive B's. With this B, Apple is now on higher ground, after having slipped to a grade of C in our last survey (from an A in 1994's survey). Apple's improvement is the result of a better-than-average score for repair frequency, which replaces an average score for first-year repairs. Dell too has improved from last year's grade of C; it now enjoys a better-than-average score for satisfaction with reliability, along with average scores on the other three measures.

Though each of the other four vendors that receive B's—Gateway, Hewlett-Packard, IBM, and NEC—all earned B's in our last survey, both Hewlett-Packard and NEC have experienced change within the satisfaction measures. Hewlett-Packard's score for satisfaction with reliability has dropped

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REPAIRS AND TECHNICAL SUPPORT

Notebook PC Vendors

		REPAIR EXPERIENCE (among those needing repairs)					TECH-SUPPORT EXPERIENCE (among those with tech-support experiences)				
○ Significantly better than average ○ Average ○ Significantly worse than average	Time on hold (minutes)	Problem solved over phone	Sent new part	Fixed on-site	PC was sent out for repair	Got a new PC	Got a run-around	Tech was knowl-edgeable	Tech tried everything to help	Prompt resolution	More than one call to resolve
Acer	○ 25.1	28%	28%	11%	50%	22%	50%	25%	10%	20%	60%
Apple	○ 7.9	12%	12%	15%	61%	N/A	22%	57%	65%	39%	43%
AST	○ 11.5	20%	15%	14%	54%	9%	23%	38%	32%	40%	28%
AT&T GIS/NCR	○ 10.0	7%	11%	26%	59%	4%	16%	44%	28%	40%	36%
Compaq	○ 12.1	16%	24%	23%	44%	5%	13%	47%	38%	40%	30%
Dell	○ 11.6	20%	38%	21%	34%	8%	19%	59%	44%	37%	28%
Digital	○ 8.1	10%	10%	14%	52%	5%	27%	36%	27%	27%	45%
Epson	○ 18.5	11%	33%	22%	33%	22%	21%	50%	21%	36%	36%
Gateway 2000	○ 12.4	41%	31%	3%	34%	11%	11%	59%	46%	41%	31%
Hewlett-Packard	○ 9.0	23%	38%	12%	27%	12%	13%	79%	63%	50%	21%
IBM	○ 10.8	21%	28%	23%	49%	5%	16%	49%	39%	42%	29%
MidWest Micro	○ 18.8	7%	25%	4%	61%	14%	32%	32%	21%	14%	50%
NEC	○ 12.8	22%	26%	11%	46%	6%	16%	45%	42%	28%	34%
Tandy	○ 7.4	21%	7%	14%	57%	7%	33%	56%	44%	33%	22%
Texas Instruments	○ 12.9	19%	24%	6%	56%	10%	7%	44%	46%	30%	31%
Toshiba	○ 12.0	19%	22%	8%	51%	8%	18%	40%	31%	32%	32%
WinBook	○ 12.4	16%	6%	N/A	78%	6%	17%	56%	43%	33%	28%
ZDS	○ 10.1	8%	25%	23%	45%	5%	29%	42%	26%	32%	19%
Zenith Data Systems	○ 27.4	32%	21%	N/A	32%	16%	42%	8%	N/A	8%	58%
AVERAGE	**13.2**	**19%**	**22%**	**15%**	**49%**	**10%**	**22%**	**46%**	**37%**	**33%**	**35%**

N/A—Not applicable: There were no responses for this question.

to average, and its score for satisfaction with repair experience has risen to better than average. NEC received better-than-average scores for satisfaction with repair experiences and technical support.

AND FIVE C'S

Acer, AT&T GIS/NCR, Digital, Tandy, and WinBook each receive average scores across the board (or a combination of scores that together constitute an average mark), which results in a grade of C. AT&T, Digital, and Tandy each received the same grade in our last study.

Acer's C represents a return to the survey after a year's absence (the result of receiving too few mentions to be considered statistically valid in our previous survey). The company returns at the same level that it left. Acer says it experienced a 68 percent growth in sales from year to year and has concurrently opened a second telephone technical-support facility in Costa Rica. The company has also adopted a new phone system and has changed field-service vendors.

WinBook appears in our survey for the first time, with average scores on all four key measures. The vendor says it has increased its telephone tech-support staff by 65 percent over the past year and has added the option of a three-year parts-and-labor warranty.

NOTEBOOK D'S

This year's notebook vendors that receive D's are AST, Epson, MidWest Micro, Texas Instruments, ZDS, and ZEOS. All garner a combination of average and worse-than-average scores on our four key survey measures. AST, MidWest Micro, and ZDS each received the same grade in last year's survey.

Epson, TI, and ZEOS earned C's last year. Epson and ZEOS now receive worse-than-average scores for satisfaction with reliability and satisfaction with technical support. TI receives average scores on the three satisfaction measures and a worse-than-average score for repair frequency. TI has expanded its service hours to 24 hours a day, 7 days a week, and has increased the number of better-trained telephone tech-support people over the past year.

As with desktop systems, no vendor receives a grade of E in the notebook group, so the vendors with D's round out the class.

WHAT IT ALL MEANS

Shopping for a new desktop or notebook PC can be a difficult and confusing experience. By conducting our Service and Reliability survey, we hope to provide information that will be valuable to you in the decision-making process. After all, speeds, feeds, and features are important, but service and support are vital as well. □

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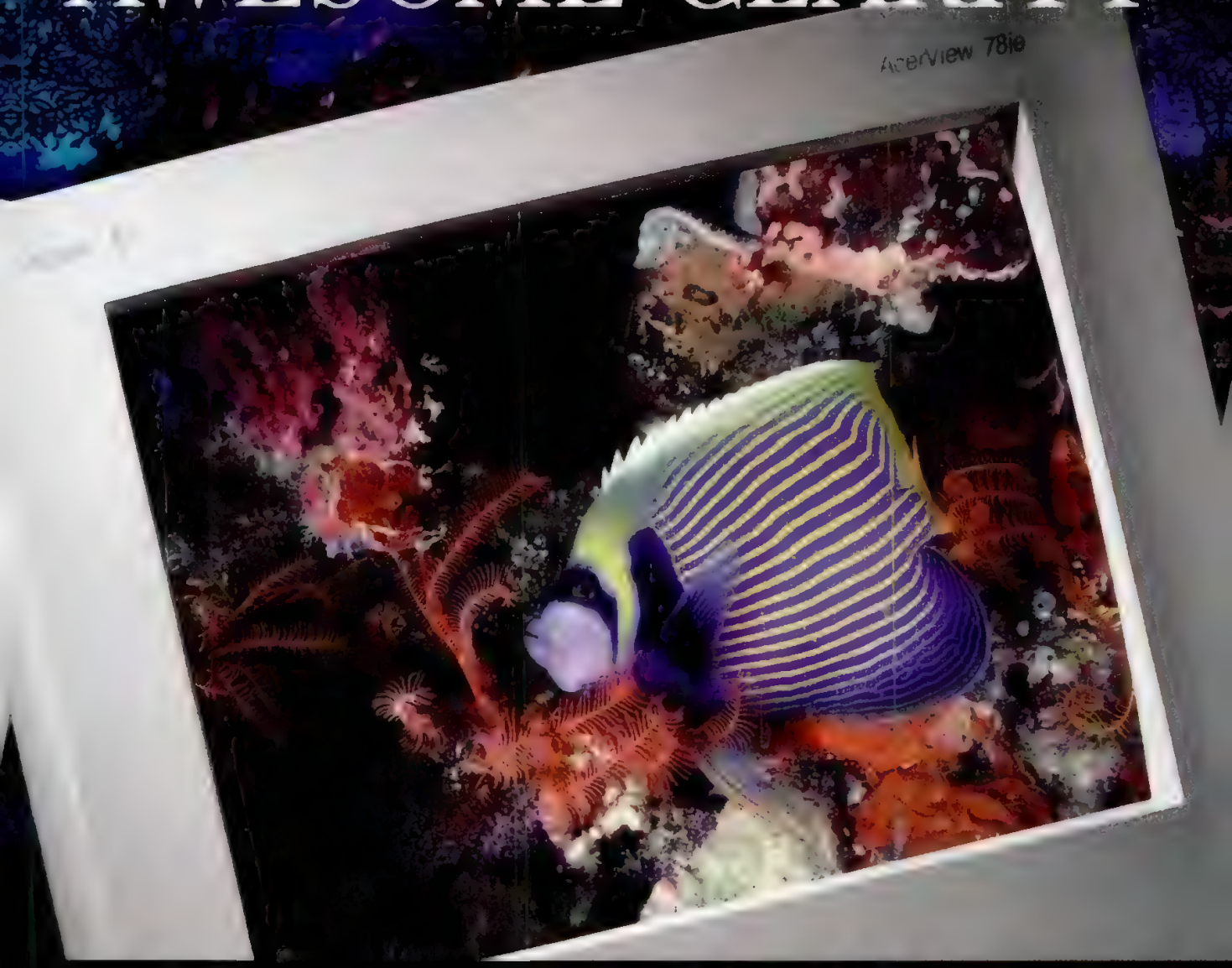

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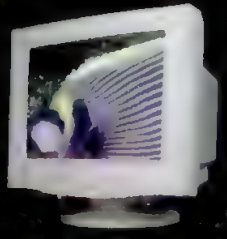

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CIRCLE 044 ON READER SERVICE CARD

Readers Rate SUPPORT & SATISFACTION

By Lance Ulanoff and Rachel Derby Teitler • Software users love to complain about inadequate support, bad manuals, and poorly designed interfaces, but our fifth annual Support and Satisfaction survey proves that in fact the relationship between users and their software is generally a love-fest.

Though it's hard to compare one product's scores directly with those of another, subscribers tended to rate the 48 surveyed products above average for support and satisfaction—despite the fact that the same readers report waiting on hold an average of 10 minutes for telephone technical support.

Those we spoke to (in informal interviews conducted outside the survey) largely believe software has vastly improved in the last five years, even as the face of technical support has radically changed.

When we first surveyed readers in 1992, telephone support and BBS access were high on their list of support methods. Of course, this was a time when telephone support was free, and BBS access was considered "going online."

With the demise of unlimited toll-free support and the emergence of the Internet and FAQs (frequently asked questions) as a force in the support industry, users not only have more technical-support options but also have practically instant access to information that once required subscriptions to proprietary help desks.

PC Magazine readers are more sophisticated than average PC users and therefore are less impressed by wizards and built-in tutorials than novice users are. Even so, most admit to using them sometimes, especially when they're just getting started with a new product. This is precisely when most people would pick up the phone to call technical support. Sure, they still call, but the other options, including better built-in support, are starting to eclipse telephone support.

As in past years, we surveyed 17,000 subscribers to gauge their overall satisfaction with the word processing, spreadsheet, database, and graphics software they use most often, as well as their operating systems and application suites. We asked subscribers to rate their satisfaction with the technical support they receive for each product, as well as their satisfaction with a number of types of support.

We used these questions not only to evaluate readers' software satisfaction but also to gain insight into where they go when they need support. Interestingly, our readers rate built-in help functions and written documentation as the kinds of technical support they rely on most.

We also asked subscribers how often they needed technical support in the past 12 months, how long they were kept on hold the most recent time they called for support (generally about 10 minutes across all product categories), and how likely they would be to recommend the purchase of the packages they use most often.

Notable findings include the surprising number of subscribers who have already adopted Microsoft Windows 95 and the suite Microsoft Office for Windows 95, which fared better in overall satisfaction than the operating system did.

One reader, Russell Morton, president of Geonav, a Hous-

RICHARD RANDS, EXECUTIVE VICE PRESIDENT
Computers for Marketing Corp.
Software developer for the marketing research industry, San Francisco, California.

Favorite applications (in order of frequency of use): WordPerfect 6.1a, NetWare 3.12, Watcom compiler for development, Lotus 1-2-3 for Windows.

On using less telephone-based technical support:

"It's the expense. It's the inconvenience of the expense. The process of setting it up and getting it cleared... it's just kind of a hassle. You don't know how much you're going to use it, so you don't know how much to buy."

PHOTOGRAPH BY ANDY FREEBERG

ton-based marine navigation systems provider, may have put it best: "I'm getting to like Windows 95. . . .When we moved from Windows for Workgroups to Windows 95, we expected it to be more of an upgrade and expected to know intrinsically how to use it. When we started using it, it came as a bit of a shock that we had to learn what is essentially a brand-new operating system. I guess, though, in the end, the effort you put into it is rewarded."

Whether you're in the midst of learning new software, upgrading an old favorite, or diving deeper into a more complex tool, our readers' survey responses and insights can help prepare you for what lies ahead.

WORD PROCESSORS

The word processing market was relatively quiet in 1995. Microsoft Corp. and Lotus Development Corp. released new versions of their programs, while WordPerfect users worried about the future of their product until Corel Corp. jumped in to save the day. Users of all these word processors expressed strong (though not widely varied) opinions about the products they use.

As we have seen in past studies, Microsoft products get high marks in general but tend to fall somewhat short when it comes to technical support.

The popularity of Microsoft's products is both a bane and a boon for the company. On the one hand, Microsoft dominates the market share in this category; respondents use Windows 95 and Windows 3.*x* versions of Microsoft Word more than WordPerfect's Windows and DOS versions combined. On the other hand, more users means increased product scrutiny and more potential requests for technical support. Still, Word holds up surprisingly well to the challenge.

Microsoft Word for Windows 95 is the only word processor included in our analysis to receive a better-than-average score for overall satisfaction. Along with the 16-bit Microsoft Word for Windows, it also receives a better-than-average score for likelihood of recommending the product. When it comes to technical support, Microsoft receives an average score for the Windows 95 version of Word.

By contrast, users of WordPerfect (both the Windows and DOS versions) give average scores for overall satisfaction, and the DOS version has a worse-than-average score for likelihood to recommend; WordPerfect for DOS, however, scores better than average for satisfaction with technical support. WordPerfect for Windows has been shipping to customers for more than two years, yet the percentage of users who need technical support remains above the average for word processors included in this survey. Lotus's word processors—Word Pro 96 Edition for Windows 95, Word Pro 96 Edition for Windows 3.1, and Ami Pro (Word Pro's predecessor)—emerge with average scores for overall satisfaction, likelihood of recommending the

HOW WE SURVEYED

Support & Satisfaction

In February 1996 we mailed questionnaires to a randomly selected sample of 17,000 *PC Magazine* subscribers. The survey was closed for tabulation on April 5, by which time we had received a 50 percent response rate. Willard and Shullman, a research firm based in Greenwich, Connecticut, tabulated the survey.

Our survey covered software applications as well as desktop PCs and notebooks. The PC results are reported in "Readers Rate Service and Reliability," also in this issue.

Respondents indicated which applications they used most often in each of six categories. Then, on a scale of 1 (worst) to 10 (best), they rated their overall satisfaction with each package and their satisfaction with technical support overall, as well as their satisfaction with a number of specific types of technical support. Only products that received at least 50 responses—which we considered the minimum amount of data necessary to produce statistically reliable results—were included in the final tabulations.

To analyze the results, we focused on one question at a time and calculated a score (an average of the ratings) for each software package. As a standard of comparison, we calculated an overall average for each measure by adding up the individual manufacturer/package scores and dividing the total by the number of manufacturers or packages rated.

▲ Significantly better than average
○ Average
▼ Significantly worse than average

In reporting our findings, we indicate how the scores for each software product compare with the overall averages. These rankings are made using a t-test, a standard statistical procedure used to identify differences from the average that are significant at the 95 percent confidence level. (See the box below.)

T-tests take into consideration the ratings, the amount of variation among the ratings, and the number of ratings received. These components determine the confidence interval for each score, or the range into which we are 95 percent certain that the score falls. The fewer the ratings and the greater the amount of variation among the ratings, the larger the range will be. Only when the range is entirely above or below the overall average is the product's score considered significantly different from the average. Therefore it's possible for one product to appear in the average range while another with the same score emerges as significantly above average, or for a vendor with a lower score to be above average while one with a higher score is not.—*Rachel Derby Teitler*

	Overall satisfaction
DATABASES	
Alpha Four (Win 3.x)	○ 7.8
dBASE (Win 3.x)	○ 7.9
FoxPro (Win 3.x)	○ 8.0
Lotus Approach (Win 3.x)	○ 7.9
Oracle (Win 3.x)	○ 8.1
MS Access (Win 3.x)	▲ 8.2
MS Access (Win 95)	▲ 8.6
Paradox (Win 3.x)	▼ 7.8
Paradox (Win 95)	○ 8.2
AVERAGE	8.0
PHICS APPLICATIONS	

The overall average is the total of all products' scores divided by the number of products.

Though two products may receive the same numerical score, when t-tested against the average, one may emerge as significantly better or worse than average while the other does not. This can happen because t-tests consider not only the individual ratings but also the number of responses and the amount of variation among them. A larger number of responses or a smaller amount of variation among the ratings increases the likelihood that a given product's score will be significantly different from the average.

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[1]Denotes internal clock speed only. Application speed will be less. [2]May not include all documentation and may differ from retail versions. [3]Excludes major holidays, during the warranty period only. Certain fees may apply. Warranty, service and support for non-IBM products are provided directly to you by the non-IBM manufacturer, supplier or publisher of the product. [4]1 year on keyboard, mouse, speakers, and microphone. Other limitations apply. Copies of IBM's limited warranty are available by calling 1 800 769-4747. IBM is a registered trademark and Aptiva, TheatreSound, and Solutions for a small planet are trademarks of International Business Machines Corporation. Windows is a trademark of the Microsoft Corporation. All other company product names and trademarks are registered trademarks of their respective companies. ©1996 IBM Corporation.

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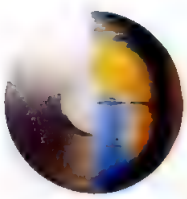

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product, and tech support.

In terms of specific types of user support, tutorials, written documentation, and built-in help functions are most widely used. For both written documentation and tutorials, WordPerfect products have an edge over the Microsoft products. Though Microsoft displays strength for support via the World Wide Web, users tend to turn to the Web far less frequently for support than to built-in help functions, the other area where Microsoft Word gets above-average support marks. And it's a good thing that users of Word turn to its built-in help often, because users calling for technical support report waiting on hold an average of over 11 minutes, almost double the time that users of Lotus's Word Pro/Ami Pro for Windows had to wait.

On the usefulness of tutorials and wizards:

"In the case of Picture Publisher, I got the job out. I got the rendering out. In fact, the tutorials and wizards got us the job."

MICHAEL JAROSZ, ARCHITECT
Skidmore, Owings, and Merrill LLP.
Architectural firm, Washington, D.C., and New York.

Favorite applications (in order of frequency of use):
AutoCAD 12, Microsoft Excel 4.0 and 5.0, WordPerfect 6.0, and Microsoft Word 6.0.

SPREADSHEETS

If the word processor market was rather quiet in 1995, the spreadsheet arena was virtually asleep. Although Microsoft shipped Excel for Windows 95, the code base was pratically a mirror image of the previous version's, and new users usually found little trouble navigating the familiar interface. Borland International and Lotus Development Corp. did not ship upgrades of their respective spreadsheet applications, Quattro Pro and Lotus 1-2-3, in 1995.

While users of both Excel for Windows 95 and Excel for Windows give those programs high marks for overall satisfaction and recommend them for purchase, users rate Excel for Windows' technical support below average. In addition, the Windows 95 version of Excel, along with all of the other spreadsheet entries, earns an average score on the same measure. As in most other categories, satisfaction with support and likelihood of recommending the purchase of a DOS product (in this case, Lotus 1-2-3 for DOS) have fallen below average.

Consistent with word processors, tutorials, written documentation, and built-in help functions are the types of support most widely used, and Excel for Windows 95 receives better-than-average scores for two of these: tutorials and built-in help. Excel for Windows 95 also garners a better-than-average score for support via the World Wide Web, but far fewer subscribers access support this way. Subscribers rate both versions of Excel worse than average for written documentation, while Windows versions of both Lotus 1-2-3 and Quattro Pro emerge as better than average. Interestingly, one of the few areas in which Lotus 1-2-3 for DOS rates above average is for support via bulletin boards.

Quattro Pro for Windows users report average satisfaction with telephone support. On the other hand, this is the only product to receive a better-than-average score for time spent on hold.

DATABASES

This year, the Windows 3.*x* and Windows 95 versions of Microsoft Access are the only two database products to receive better-than-average scores for both overall satisfaction and likelihood of recommending the product. In fact, no other products in this category rate better than average in either of these two areas.

As with other product categories, users continue to rely heavily on built-in support functions; roughly two-thirds of all database users indicated that they use this kind of help. And although users can now find most manuals electronically (usually on the CD-ROM versions of these applications), database users report that they grab for the hard copy to find the information they need.

The Windows 95 version of Access is the only product to garner a better-than-average score for satisfaction with overall technical support. Both versions of Access receive better-than-average scores for satisfaction with built-in help functions, and the Windows 95 version earns better-than-average marks for tutorials and support via the World Wide Web. But Access for Windows 95 receives a worse-than-average score for written documentation.

Most other database tools—including Alpha Software Corp.'s Alpha Four, Lotus's Approach, and Microsoft's FoxPro—emerge as average for support and satisfaction. Our survey of Borland's Paradox for Windows users found them less satisfied than average and, along with users of Borland's dBASE, not too likely to recommend the product to others. Fortunately, Paradox users experience better-than-average response times when calling for technical support. Oracle Corp.'s Oracle falls a bit short in some areas of technical support: Users accessing technical support via the telephone, the World Wide Web, or built-in help functions report less satisfaction than the average.

PHOTOGRAPH BY KATHERINE LAMBERT

How Much Memory Do You Really Need?

Kingston TECHNOLOGY CORPORATION

Microsoft

Reading The Chart.

The chart to the right provides some reference points to help you assess your optimum memory needs. Find your operating system on the left, and cross-reference it with your typical usage patterns to see what adjustments, if any, should be made to the baseline configuration.

Memory recommendations listed here are based on industry data and independent studies.

Costs

Insufficient system memory can severely impede your computer's performance and hinder your work. That's a waste of time. A system loaded down with too much memory is a waste of money. But, economically speaking, adding memory when you really need it makes sense.

"The payback is so fast you'll likely have earned back the memory before you even pay the invoice." — *PC Computing*

Benefits

"The quickest, easiest — and one of the most popular — ways to increase system performance is to increase system RAM." — *PC Magazine Labs*

Adding memory allows you to do more work in less time. You can run more applications simultaneously and work with larger and more complex files. Workgroups are possible. Printing is faster. And, best of all, you can eliminate long delays and quickly switch among the applications you use most often.

High–Performance Users

Some applications use more memory because they generate very large files and complex documents. Graphics, desktop publishing, multimedia software, and the like generate much larger files than spreadsheets or word processors. More of the file needs to be in memory at the same time to avoid "disk-thrashing" swap files. Otherwise, you spend time waiting for refreshed images.

Although 16MB to 32MB is sufficient memory for multitasking with almost all standard business applications, it won't be enough for many high-performance needs.

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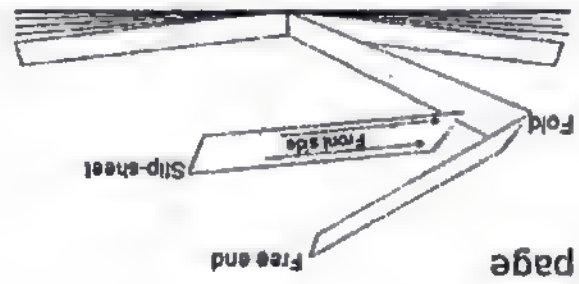

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The Three Most Important Factors.

When figuring your memory requirements, consider three things: the optimum memory configuration of your operating system, your usage patterns, and your hardware.

The Operating System

Your operating system needs a specific amount of memory to maximize its speed and efficiency. Fortunately, countless hours of testing have taken the guesswork out of determining just what those specific amounts are. Baselines have been identified for each of the major operating systems and dozens of the most popular business applications.

Upgrading to the baseline for your particular operating system is the best place to start.

Usage Patterns

Your *usage pattern* is the way you most typically use your computer. Whether you'll need more or less memory than the baseline depends not only on what applications you use, but, more important, on how you use them. Different people use different combinations of applications. And while some people use a given application to its fullest potential, others might use only a few functions. It all depends on what kinds of tasks you're trying to accomplish, such as administrative, analysis, or design tasks, for example.

Upgrading to a memory configuration that's three to five times the size of the files you typically create will maximize the potential of leading-edge applications.

Hardware

Your hardware needs to be considered as well, especially your microprocessor. In general, faster processors have higher performance curves and will show more of a performance increase from larger memory capacities than slower machines. The peripherals attached to your system can also be key indicators of memory demand. Larger monitors, for example, need more memory to display information on their big screens. Likewise, CD-ROMs, scanners, and graphics accelerators are all indicators that memory-intensive applications are being used.

For faster machines and multiple peripherals, go to the higher end of the recommended ranges.

It's Not An Easy Question To Answer. But There Is A Way.

Memory used to be a simple matter. A computer came with a set amount of memory, and software designers stayed within those limits. But today, new applications are pushing the limits of memory requirements. And software companies are keeping their memory recommendations low in order to make their software look more attractive. That doesn't always help the people who will actually use those programs.

The fact is, every user's needs are different. People use their computers in different ways, to accomplish different tasks. Some people demand the maximum their systems can deliver. Other people need less.

Ultimately, you can figure out how much memory you really need. Independent laboratory tests have proven that most operating systems and applications are tuned to specific memory requirements. That means there's an optimum amount of memory for the way you use your computer. By considering a few key factors, you can easily and accurately determine your specific memory requirements.

"Software Space"

Computer memory is hardware, but memory is really a software issue. RAM is primarily "software space." It's where your operating system, applications, drivers, and documents all come together. The larger your software space, the more room you'll have to work with multiple applications, large files, and complex documents.

When you don't have enough memory, your computer spends a lot of time hitting the hard disk. That can slow your system to a crawl. In these cases, increasing your RAM can have a tremendous impact on system performance.

Beyond The "Standard 8"

The previous standard 8MB configuration is quickly being replaced by the new "Standard 16." There's no doubt about it. The object-oriented interfaces and the multitasking, multithreading, and networking capabilities built into new operating systems are making greater demands on system resources. And new 32-bit applications designed for these systems are pushing the minimum requirements even beyond 16MB.

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Different Users, Different Memory Needs.

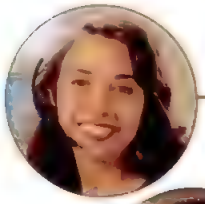
We understand the challenges you face. That's why we created this guide. It's designed to help you find the right amount of memory for your specific needs.

IS Manager

"I have to allocate system resources for the entire company and keep the network up and running. I need to know exactly what each person really needs — no more, no less."

Executive Manager

"My presentations are critical. And when I build a presentation, I use a lot of different elements — graphics, charts, text, and slides. They said 8MB would be fine, but it just doesn't work for me. I need enough memory to handle not only my presentations, but the dozens of reports I analyze every week as well."



Customer Service Representative

"When I've got two phones ringing and a customer on hold, I need instant answers from the database. I need enough memory for fast queries and quick switches from one database to another."

Administrative Assistant

"Immediate demands and constant revisions — that's my work. When the boss says, 'I want it yesterday,' I don't have time to sit and watch the hourglass. I have to work with multiple documents, print them out quickly, and get on to the next task. I need enough memory for all the different applications I use, like my word processor, spreadsheet, fax, and e-mail programs."

Financial Analyst

"I spend most of my time working with numbers. And sometimes I have to wade through massive amounts of information. Huge spreadsheets, large databases, and frequent reports— I need enough memory to "crunch" those numbers, so I don't get crunched by deadlines."

Designer

"I probably do the most memory-intensive work in the whole company. Illustration, pre-press layout, scanned images, real-time video — those kinds of tasks eat memory like popcorn. The amount of memory I need to be productive may sound like a lot, but I can guarantee you that I use every single byte."

Engineer

"I need a lot more memory than your typical business user. The 3-D models I build are incredibly complex. Even minor design changes can be frustrating because of slow regenerations. I need enough memory to work with super large design files — to rotate, render, and manipulate the models on-screen. And I need enough memory to run the simulated tests that are crucial to well-designed parts."

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Animation, complex photo-editing, real-time video, 3D CAD, solid modeling, finite element analysis	48 – 256MB

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Fax/communications, database administration, spreadsheets; >2 applications open at a time	20 – 24MB
Complex documents, accounting, business graphics, presentation software	24 – 32MB
Proposals, reports, spreadsheets, business graphics, databases, scheduling, e-mail, fax/communications, presentations	24 – 28MB
Complex presentations, sales/market analysis, project management	28 – 32MB
Statistical applications, large databases, research/technical analysis, complex presentations, video conferencing	32 – 40MB
Page layout, 2-4 color line drawings, simple image manipulation, simple graphics	32 – 48MB
2D CAD, rendering, multimedia presentations, simple photo-editing	48 – 64MB
Animation, complex photo-editing, real-time video, 3D CAD, solid modeling, finite element analysis	64 – 256MB

Word processing, e-mail, data-entry	8 – 12MB
Fax/communications, database administration, spreadsheets; >2 applications open at a time	12 – 16MB
Complex documents, accounting, business graphics, presentation software	16 – 24MB
Proposals, reports, spreadsheets, business graphics, databases, scheduling, e-mail, fax/communications, presentations	16 – 20MB
Complex presentations, sales/market analysis, project management	20 – 24MB
Statistical applications, large databases, research/technical analysis, complex presentations, video conferencing	24 – 32MB
Page layout, 2-4 color line drawings, simple image manipulation, simple graphics	32 – 48MB
2D CAD, rendering, multimedia presentations, simple photo-editing	48 – 64MB
Animation, complex photo-editing, real-time video, 3D CAD, solid modeling, finite element analysis	64 – 256MB

Word processing, e-mail, data-entry	12 – 16MB
Fax/communications, database administration, spreadsheets; >2 applications open at a time	16 – 20MB
Complex documents, accounting, business graphics, presentation software	20 – 28MB
Proposals, reports, spreadsheets, business graphics, databases, scheduling, e-mail, fax/communications, presentations	20 – 24MB
Complex presentations, sales/market analysis, project management	24 – 28MB
Statistical applications, large databases, research/technical analysis, complex presentations, video conferencing	28 – 36MB
Page layout, 2-4 color line drawings, simple image manipulation, simple graphics	32 – 48MB
2D CAD, rendering, multimedia presentations, simple photo-editing	48 – 64MB
Animation, complex photo-editing, real-time video, 3D CAD, solid modeling, finite element analysis	64 – 256MB

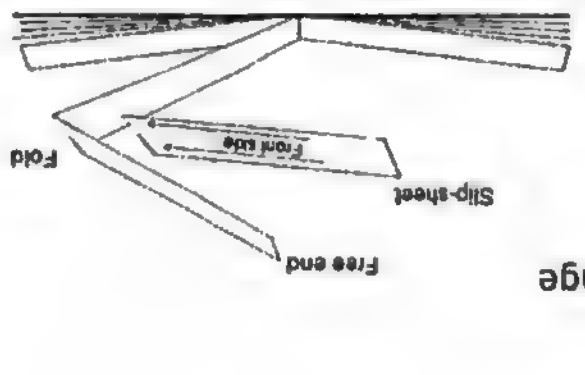
* Please note These figures reflect work done in a typical PC environment. Higher-end workstation tasks may require up to 2GB or more.

Folded edge of the page

GbsSlipSheet-001

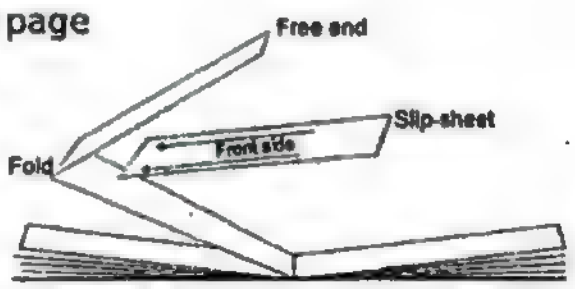
Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



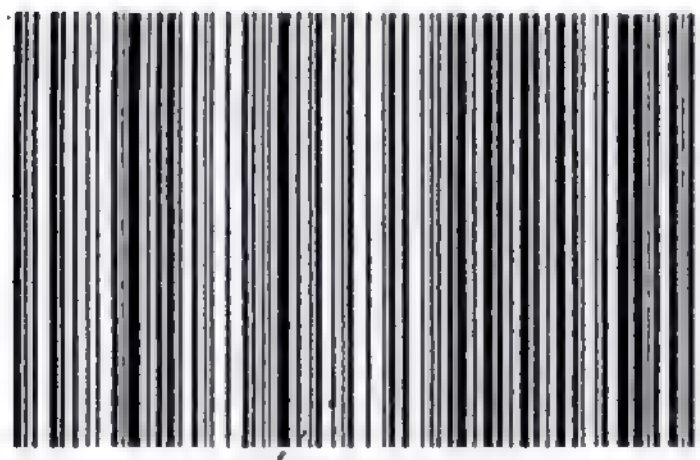
Inverted Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



Inverted Back

1. Follow instructions on the other side



Back

1. Follow instructions on the other side

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Windows® & Windows for Workgroups

Windows shows a dramatic increase in performance with 8MB over 4MB. That suggests a more realistic minimum of 8MB. If you require extensive multi-tasking, high-end graphic design, or complex numerical processing, Windows 3.X will not benefit from additional memory as effectively as the 32-bit operating systems which are currently available.

Baseline: 4 – 16MB

Administrative & Service	Light-
	Medium-
	Heavy-
Executives & Analysts	Light-
	Medium-
	Heavy-
Engineers & Designers	Light-
	Medium-
	Heavy-

Windows 95

Windows 95 will load with 4MB, but you'll need 8MB to begin working with 32-bit native applications. Other tests show significant improvement in Windows 95 performance at 16MB and, because Windows 95 performance continues to scale with additional memory, the more you add, the better your performance.

Baseline: 8 – 20MB

Administrative & Service	Light-
	Medium-
	Heavy-
Executives & Analysts	Light-
	Medium-
	Heavy-
Engineers & Designers	Light-
	Medium-
	Heavy-

Windows NT™

Windows NT will load with 12MB, but in order to take full advantage of NT and all of its functionality, you'll want to start with 16MB. Of all the popular operating systems, Windows NT performs the best at 32MB. Like Windows 95, Windows NT's performance scales with additional RAM.

Baseline: 16 – 32MB

Administrative & Service	Light-
	Medium-
	Heavy-
Executives & Analysts	Light-
	Medium-
	Heavy-
Engineers & Designers	Light-
	Medium-
	Heavy-

Macintosh OS

The Macintosh operating system manages memory in substantially different ways than other systems. Still, System 7.5 users will find that 5MB to 8MB is a bare minimum. When using PowerMac™ applications, plan on a range between 10MB and 12MB

Baseline: 8 – 16MB

Administrative & Service	Light-
	Medium-
	Heavy-
Executives & Analysts	Light-
	Medium-
	Heavy-
Engineers & Designers	Light-
	Medium
	Heavy-

OS/2®

OS/2 is a true multitasking system, so it's more likely that you'll have multiple applications loaded in this environment. IBM recommends using 16MB for OS/2, and this system appears to improve in performance up through 20MB.

Baseline: 12 – 20MB

Administrative & Service	Light-
	Medium-
	Heavy-
Executives & Analysts	Light-
	Medium-
	Heavy-
Engineers & Designers	Light-
	Medium-
	Heavy-

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PC MAGAZINE CIRCLE 106 ON READER SERVICE CARD

HOW READERS RATED

Software

● Significantly better than average
○ Average
▼ Significantly worse than average

	Overall satisfaction	Likelihood to recommend
WORD PROCESSORS		
Ami Pro/Word Pro (Win 3.x)	○ 8.5	○ 8.3
Ami Pro/Word Pro (Win 95)	○ 8.4	○ 8.6
MS Word (Win 3.x)	○ 8.7	● 8.8
MS Word (Win 95)	● 8.9	● 9.0
WordPerfect for DOS	○ 8.6	▼ 7.9
WordPerfect (Win 3.x)	○ 8.5	○ 8.3
AVERAGE	8.6	8.5
SPREADSHEETS		
Lotus 1-2-3 for DOS	▼ 8.1	▼ 7.2
Lotus 1-2-3 (Win 3.x)	○ 8.7	○ 8.4
MS Excel (Win 3.x)	● 8.7	● 8.8
MS Excel (Win 95)	● 8.9	● 9.1
Quattro Pro (Win 3.x)	○ 8.6	○ 8.2
AVERAGE	8.6	8.3
DATABASES		
Alpha Four (Win 3.x)	○ 7.8	○ 7.4
dBASE (Win 3.x)	○ 7.9	▼ 7.4
FoxPro (Win 3.x)	○ 8.0	○ 7.7
Lotus Approach (Win 3.x)	○ 7.9	○ 7.8
Oracle (Win 3.x)	○ 8.1	○ 8.1
MS Access (Win 3.x)	● 8.2	● 8.3
MS Access (Win 95)	● 8.6	● 8.7
Paradox (Win 3.x)	▼ 7.8	▼ 7.2
Paradox (Win 95)	○ 8.2	○ 8.2
AVERAGE	8.0	7.9
GRAPHICS APPLICATIONS		
Adobe Illustrator	○ 8.4	○ 8.3
Adobe Photoshop (Win 3.x)	● 8.7	● 8.6
CorelDraw (Win 3.x)	○ 8.3	○ 8.1
CorelDraw (Win 95)	○ 8.4	○ 8.5
Freelance Graphics (Win 3.x)	▼ 8.0	▼ 7.8
Harvard Graphics (Win 3.x)	▼ 7.8	▼ 7.4
Micrografx ABC Graphics Suite (Win 95)	○ 8.1	▼ 7.5
MS Publisher (Win 3.x)	○ 8.2	○ 8.3
MS Publisher (Win 95)	● 8.6	● 8.7
PageMaker (Win 3.x)	○ 8.3	○ 8.2
PageMaker (Win 95)	● 8.7	● 8.9
PowerPoint (Win 3.x)	▼ 8.0	○ 8.1
PowerPoint (Win 95)	○ 8.3	● 8.4
AVERAGE	8.3	8.2
OSs/ENVIRONMENTS		
MS-DOS	○ 8.4	▼ 7.9
MS Windows 3.x	▼ 7.9	▼ 7.7
MS Windows 95	▼ 8.3	● 8.6
MS Windows NT	● 8.9	● 9.1
OS/2 Warp	● 8.9	○ 8.4
AVERAGE	8.5	8.3
SUITES/INTEGRATED SOFTWARE		
ClarisWorks (Win 3.x)	○ 7.7	○ 7.5
MS Office (Win 3.x)	● 8.5	● 8.6
MS Office (Win 95)	● 8.8	● 8.9
MS Works (Win 3.x)	○ 8.3	○ 8.0
MS Works (Win 95)	○ 8.5	● 8.5
PerfectOffice (Win 3.x)	○ 8.1	▼ 7.6
SmartSuite (Win 3.x)	○ 8.2	▼ 7.8
SmartSuite (Win 95)	○ 8.3	○ 8.3
AVERAGE	8.3	8.1

GRAPHICS

With a mix of illustration, desktop publishing, and presentation graphics products, this category touches on all aspects of graphics software. Though Adobe Systems' two packages—PageMaker and Photoshop for Windows 95—fare well, the clear winner here is Microsoft Publisher for Windows 95. It's the only product in any of the categories studied to have a clean sweep, with better-than-average scores for overall satisfaction, satisfaction with technical support, and likelihood of recommending the product.

Interestingly, however, the Windows 3.*x* version of Microsoft Publisher earns a better-than-average score only for satisfaction with technical support. As one would expect, both the Windows 3.*x* and Windows 95 versions of Microsoft Publisher tend to do well on the specific types of technical support used most often: built-in help, written documentation, and tutorials.

While PageMaker and Photoshop garner better-than-average scores for both overall satisfaction and likelihood of recommending the product, Microsoft PowerPoint has a somewhat disjointed collection of scores: The Windows 95 version receives better-than-average scores for satisfaction with technical support and likelihood to recommend, yet only an average score for overall satisfaction, and the Windows 3.*x* version receives a worse-than-average score for overall satisfaction and average scores in the other two areas.

Corel Corp.'s CorelDraw for Windows users reveal that they tend to wait longer than average on the telephone when they call for technical support. Users of Software Publishing Corp.'s Harvard Graphics for Windows 3.*x* and Lotus's Freelance Graphics for Windows 3.*x* are less satisfied than average overall, and they are less likely to recommend those products to someone else.

Users of Micrografx's ABC Graphics Suite 95 display average satisfaction with the product, though they are also less likely than average to recommend the product to others. Readers do, however, applaud Micrografx's Web support.

OPERATING SYSTEMS/ENVIRONMENTS

Whether you consider it the most significant product release of the year or the biggest product hype of all time, Microsoft Windows 95 certainly made its mark in 1995. Although Windows 3.*x* and Windows 95 receive worse-than-average scores for overall satisfaction, users still say they would recommend Windows 95. The real story here, however, may be Windows NT, the only product to receive better-than-average scores for overall support and likelihood to recommend. Not surprisingly, Windows 3.*x* and DOS have fallen in support popularity.

As we've seen in past years, users of products with smaller installed bases

Our Contributors: RACHEL DERBY TEITLER is a senior research manager for Ziff-Davis Corporate Research. LANCE N. ULANOFF was the senior associate editor in charge of this story.

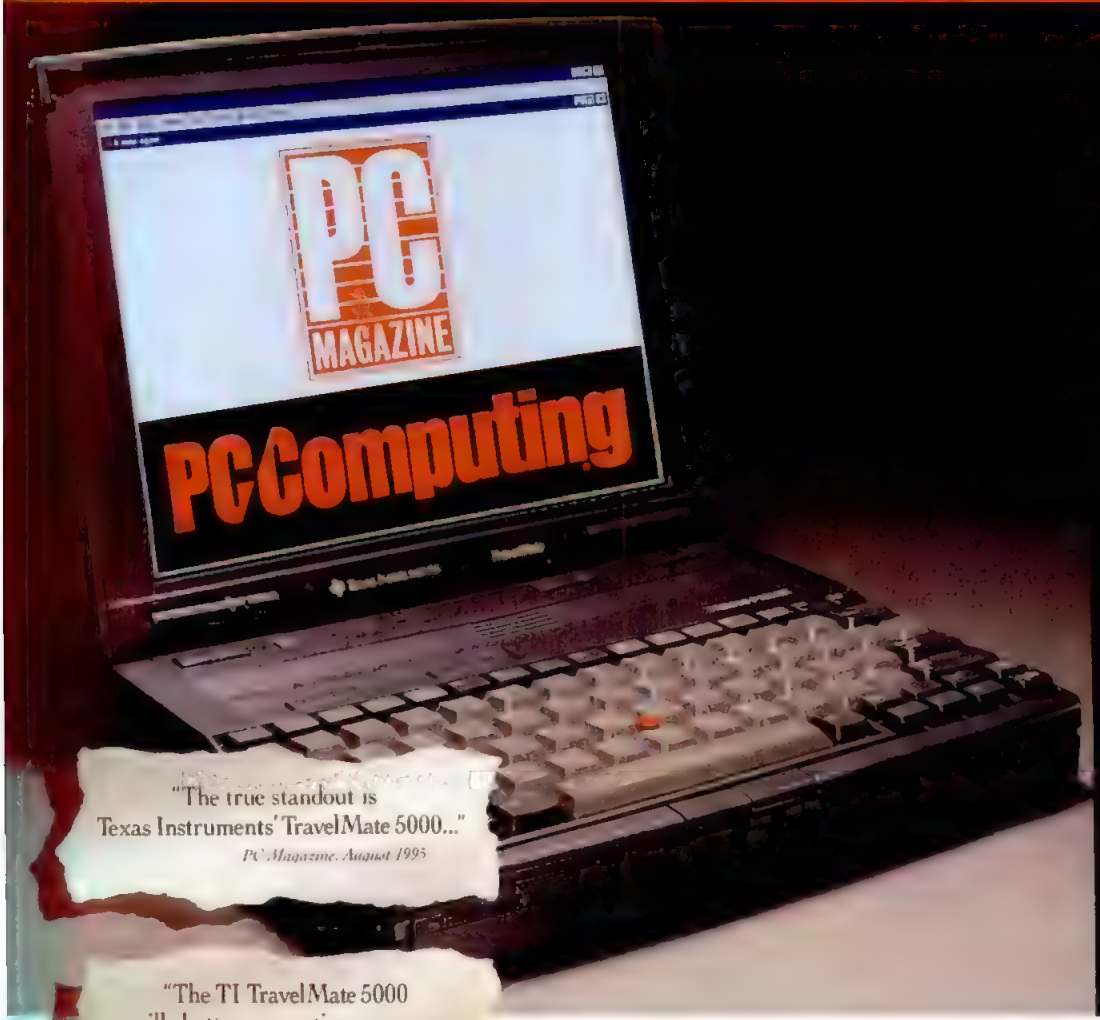
HOW READERS RATED

Technical Support

▲ Significantly better than average
○ Average
▼ Significantly worse than average

	Overall technical support	Written documentation	Tutorials	Replacement of defective disks	Support via World Wide Web	Support via online services	Support via BBS	Built-in help	% needing tech support in past 12 months
WORD PROCESSORS									
Ami Pro/Word Pro (Win 3.x)	○ 7.7	○ 7.4	○ 7.3	○ 8.3	○ 7.1	○ 6.7	○ 7.3	○ 7.4	▲ 14%
Word Pro (Win 95)	○ 8.0	○ 7.1	○ 7.8	▲ 10.0	○ 6.7	○ 7.3	○ 8.3	○ 8.0	○ 18%
MS Word (Win 3.x)	▼ 7.7	○ 7.2	▼ 7.3	○ 8.6	○ 7.3	○ 7.2	▼ 7.1	○ 7.5	▲ 17%
MS Word (Win 95)	○ 8.0	▼ 6.7	○ 7.4	○ 8.7	▲ 7.8	○ 7.5	○ 7.7	▲ 7.9	○ 20%
WordPerfect for DOS	▲ 8.3	▲ 7.8	○ 7.5	○ 8.9	○ 7.2	○ 7.7	○ 8.1	▼ 7.4	▲ 15%
WordPerfect (Win 3.x)	○ 8.0	▲ 7.8	○ 7.4	○ 8.5	○ 7.1	○ 7.4	○ 7.4	○ 7.5	▼ 26%
AVERAGE	**7.9**	**7.3**	**7.5**	**8.8**	**7.2**	**7.3**	**7.7**	**7.6**	**18%**
SPREADSHEETS									
Lotus 1-2-3 for DOS	○ 7.7	○ 7.5	○ 7.0	○ 8.3	○ 7.8	○ 7.1	▲ 8.9	▼ 6.8	▲ 7%
Lotus 1-2-3 (Win 3.x)	○ 7.9	▲ 7.5	○ 7.5	○ 8.1	○ 6.9	○ 6.8	○ 7.9	○ 7.5	○ 14%
MS Excel (Win 3.x)	▼ 7.7	▼ 7.2	○ 7.2	○ 8.3	○ 7.3	○ 7.2	▼ 7.1	○ 7.4	▼ 14%
MS Excel (Win 95)	○ 8.0	▼ 6.7	▲ 7.5	○ 8.9	▲ 7.8	○ 7.7	○ 7.8	▲ 7.9	○ 13%
Quattro Pro (Win 3.x)	○ 8.0	▲ 7.6	○ 7.2	○ 9.0	○ 7.7	○ 7.9	○ 7.9	○ 7.5	○ 11%
AVERAGE	**7.9**	**7.3**	**7.3**	**8.5**	**7.5**	**7.3**	**7.9**	**7.4**	**12%**
DATABASES									
Alpha Four (Win 3.x)	○ 7.7	○ 7.4	○ 7.4	○ 9.3	○ 5.9	○ 7.0	○ 7.0	○ 6.7	○ 20%
dBASE (Win 3.x)	○ 7.7	○ 7.4	○ 7.3	○ 8.1	○ 7.6	○ 7.7	○ 7.2	○ 7.3	▲ 12%
FoxPro (Win 3.x)	○ 7.6	○ 7.2	▼ 6.7	○ 8.6	○ 7.6	○ 7.7	○ 7.6	○ 7.1	○ 15%
Lotus Approach (Win 3.x)	○ 7.8	○ 6.9	○ 7.1	○ 7.4	○ 7.6	○ 6.7	○ 6.8	○ 7.0	▲ 12%
MS Access (Win 3.x)	○ 7.7	○ 7.0	○ 7.1	○ 8.5	○ 7.4	○ 7.4	○ 6.9	▲ 7.4	○ 16%
MS Access (Win 95)	▲ 8.1	▼ 6.6	▲ 7.5	○ 8.9	▲ 7.8	○ 7.7	○ 7.5	▲ 7.8	○ 15%
Oracle (Win 3.x)	○ 7.2	○ 6.8	○ 6.8	○ 5.2	▼ 5.5	○ 6.2	○ 7.4	▼ 6.1	▼ 33%
Paradox (Win 3.x)	○ 7.7	○ 7.2	▼ 6.8	○ 8.7	○ 7.6	○ 7.9	○ 7.8	○ 6.8	○ 15%
Paradox (Win 95)	○ 7.8	○ 7.4	▲ 7.8	○ 8.7	○ 7.1	○ 6.6	○ 5.2	○ 7.5	○ 19%
AVERAGE	**7.7**	**7.1**	**7.2**	**8.1**	**7.1**	**7.2**	**7.1**	**7.1**	**17%**
GRAPHICS APPLICATIONS									
Adobe Illustrator	○ 7.2	○ 7.8	○ 7.7	▲ 10.0	○ 8.1	○ 7.8	○ 7.3	○ 7.7	○ 12%
Adobe Photoshop (Win 3.x)	○ 7.8	○ 7.5	○ 7.5	○ 8.5	○ 7.7	○ 7.4	○ 7.2	○ 7.2	○ 19%
CorelDraw (Win 3.x)	○ 7.6	○ 7.3	▼ 7.0	○ 8.7	▼ 6.8	○ 7.0	○ 7.6	▼ 6.9	▼ 15%
CorelDraw (Win 95)	○ 7.6	○ 7.1	○ 7.0	○ 8.6	▼ 6.6	○ 7.1	○ 7.6	○ 7.1	▼ 25%
Freelance Graphics (Win 3.x)	○ 7.4	○ 7.3	○ 7.4	○ 8.1	○ 7.1	○ 6.3	○ 7.5	○ 7.1	○ 11%
Harvard Graphics (Win 3.x)	○ 7.7	○ 7.1	○ 7.0	○ 8.5	○ 7.1	○ 6.9	○ 7.8	▼ 6.9	○ 11%
Micrografx ABC Graphics Suite (Win 95)	○ 7.3	○ 6.8	○ 7.1	○ 7.8	▲ 9.3	○ 8.4	○ 7.0	○ 6.8	▲ 6%
MS Publisher (Win 3.x)	▲ 8.2	▲ 7.5	▲ 7.7	○ 8.9	○ 7.6	○ 7.2	○ 8.1	▲ 7.8	▲ 6%
MS Publisher (Win 95)	▲ 8.2	○ 6.9	▲ 7.8	▲ 9.6	▲ 8.3	○ 8.1	○ 7.9	▲ 7.9	○ 13%
PageMaker (Win 3.x)	○ 7.5	○ 7.4	○ 6.9	○ 7.3	○ 6.5	○ 7.1	○ 7.2	○ 7.0	▼ 20%
PageMaker (Win 95)	○ 8.2	○ 7.8	○ 7.9	▼ 6.0	○ 7.9	○ 7.8	○ 7.5	○ 7.8	○ 16%
PowerPoint (Win 3.x)	○ 7.6	▼ 7.0	▼ 7.1	○ 8.7	○ 7.4	○ 7.2	○ 7.5	○ 7.2	▲ 9%
PowerPoint (Win 95)	▲ 8.1	▼ 6.7	○ 7.3	○ 8.3	○ 7.7	○ 7.4	○ 6.9	▲ 7.8	▲ 8%
AVERAGE	**7.7**	**7.2**	**7.3**	**8.4**	**7.5**	**7.4**	**7.5**	**7.3**	**13%**
OSs/ENVIRONMENTS									
MS-DOS	○ 7.6	▲ 7.2	○ 7.3	○ 7.3	○ 7.8	○ 7.5	○ 7.5	○ 7.3	▲ 7%
MS Windows 3.x	▼ 7.3	○ 6.7	▼ 6.7	○ 8.1	▼ 7.2	▼ 7.0	○ 7.1	▼ 6.6	▲ 16%

BEFORE YOU BUY, GET PLENTY OF QUOTES.



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CIRCLE 246 ON READER SERVICE CARD

HOW READERS RATED

Technical Support

▲ Significantly better than average
○ Average
▼ Significantly worse than average

	Overall technical support	Written documentation	Tutorials	Replacement of defective disks	Support via World Wide Web	Support via online services	Support via BBS	Built-in help	% needing tech support in past 12 months
MS Windows 95	○ 7.5	▼ 5.8	○ 7.0	○ 8.0	○ 7.7	○ 7.4	○ 7.3	▲ 7.5	▼ 35%
MS Windows NT	○ 7.2	○ 6.6	○ 6.9	○ 8.7	○ 7.5	○ 7.2	○ 7.1	○ 7.1	▼ 36%
OS/2 Warp	▲ 8.0	○ 6.6	○ 7.3	○ 8.7	▲ 8.5	○ 8.0	▲ 8.4	▲ 7.7	▼ 51%
AVERAGE	**7.5**	**6.6**	**7.0**	**8.2**	**7.7**	**7.4**	**7.5**	**7.2**	**29%**
SUITES/INTEGRATED SOFTWARE									
ClarisWorks (Win 3.x)	○ 8.6	○ 8.7	○ 7.3	○ 5.7	○ 6.7	○ 6.3	○ 6.3	○ 7.1	○ 13%
MS Office (Win 3.x)	▼ 7.6	○ 7.0	○ 7.1	○ 8.3	○ 7.4	▲ 7.2	○ 7.1	○ 7.3	▲ 12%
MS Office (Win 95)	○ 7.9	▼ 6.5	○ 7.3	▲ 8.9	○ 7.8	▲ 7.6	○ 7.6	▲ 7.8	○ 15%
MS Works (Win 3.x)	○ 8.0	▲ 7.3	▲ 7.8	○ 7.9	○ 7.5	○ 6.6	○ 7.5	○ 7.5	▲ 8%
MS Works (Win 95)	○ 8.3	○ 6.6	○ 7.5	○ 7.4	○ 8.3	▲ 8.3	○ 8.2	▲ 7.8	○ 12%
PerfectOffice (Win 3.x)	○ 7.7	○ 7.1	○ 7.2	○ 8.4	○ 7.8	▲ 7.8	○ 7.7	○ 7.4	▼ 28%
SmartSuite (Win 3.x)	▼ 7.5	○ 6.9	○ 7.4	○ 7.4	○ 7.4	○ 5.8	○ 7.1	○ 7.3	○ 13%
SmartSuite (Win 95)	○ 8.3	○ 7.0	○ 7.0	○ 8.0	○ 7.1	▼ N/A	▲ 8.0	○ 7.4	○ 10%
AVERAGE	**8.0**	**6.9**	**7.3**	**7.7**	**7.5**	**6.2**	**7.4**	**7.4**	**14%**

N/A—Not applicable: There were no responses for this question.

stand up and defend their operating system choices when given the chance. IBM's OS/2 Warp and Microsoft Windows NT, rated by 2 percent and 4 percent of subscribers respectively, are the only products rated better than average for overall satisfaction.

In overall technical support, OS/2 shines again: Users rate its support above average, particularly on the telephone, on the World Wide Web, and in its built-in help functions. Notably, Microsoft Windows 3.*x* falls short in technical support, and it receives worse-than-average scores for telephone support, tutorials, and support via the Web and online services, as well as for its built-in help functions. And although users give Windows 95 high marks for its built-in help functions, it's the only product that receives a significantly below-average score for written documentation—a form of support for which only MS-DOS garners an above-average score.

PHOTOGRAPH BY ROBERT A. FLISCHEL

On technical support for Windows 95:

"We required a fair amount of assistance in figuring out how to get Windows 95 to coexist with NetWare 3.12, but working with Microsoft on Windows 95 has been far easier than it was with other Microsoft products."

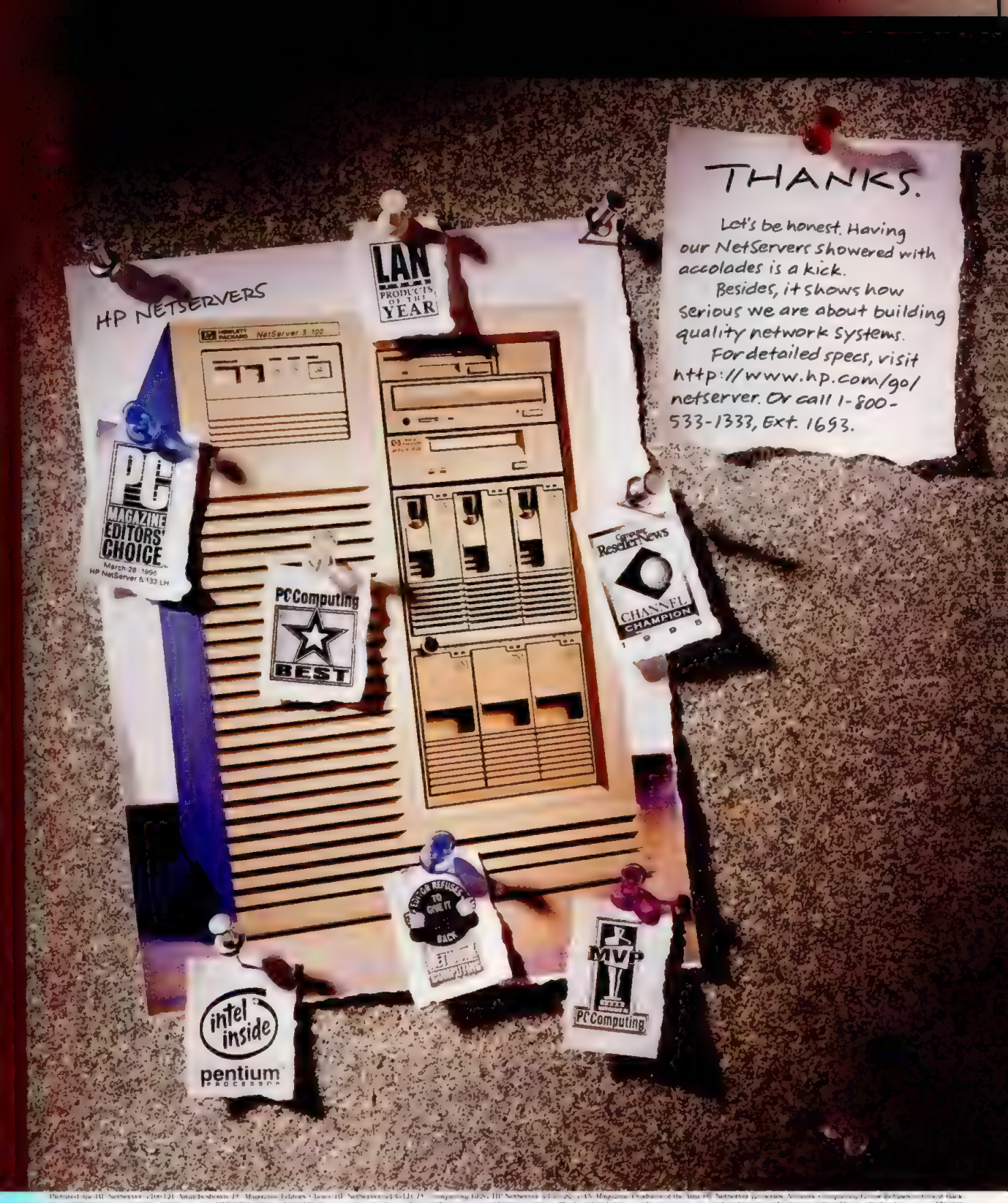
LLOYD PILLSBURY, CHIEF EXECUTIVE OFFICER
Production Resources Inc.
Specialty machine tool distributor.
West Chester, Ohio.

Favorite applications (in order of frequency of use): Microsoft Word for Windows 95, ACT! for Windows 2.6, RealWorld Accounting and Business Software 7.0, POI proprietary order-entry software.

SUITES/INTEGRATED APPLICATIONS

In the world of suites and integrated applications, two new products shipped in 1995: Microsoft Office for Windows 95 and Lotus's SmartSuite 96 for Windows 95. And as one would expect from perusing the scores for individual applications, Microsoft Office for Windows 3.*x* and Office for Windows 95 have the strongest showings among the suites. Each receives better-than-average scores for both overall satisfaction and the likelihood of recommending the product.

The only other entry to perform well on either of these measures is the *integrated* application Microsoft Works for Windows 95, which obtains a better-than-average score for likelihood to recommend. Claris Corp.'s ClarisWorks, another integrated application, receives average scores for both overall satisfaction and



Pictured: the HP NetServer S 100 LH Award Winners: *PC Magazine* Editors' Choice HP NetServer S 133 LH; *PC Computing* BEST HP NetServer S 133 LH; *PC Magazine* Finalist of the Year HP NetServer S Series; Network Computing Editors' Readers' Choice Award HP NetServer S 100 LH4; *PC Computing* MVP HP NetServer S 100 LH; *Computer Reseller News* Channel Champion Award NetServer Series. The Intel Inside logo and Pentium are registered trademarks of Intel Corp. © 1995 Hewlett-Packard Company 1954/4

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HOW READERS RATED

Telephone Technical Support

▲ Significantly better than average
○ Average
▼ Significantly worse than average

	Satisfaction with phone support	Minutes on hold
WORD PROCESSORS		
Ami Pro/Word Pro (Win 3.x)	○ 7.6	▲ 6.6
Word Pro (Win 95)	○ 7.8	○ 9.6
MS Word (Win 3.x)	▼ 7.4	▼ 11.2
MS Word (Win 95)	○ 7.5	▼ 11.6
WordPerfect for DOS	▲ 8.2	○ 8.2
WordPerfect (Win 3.x)	○ 8.0	○ 9.7
AVERAGE	7.7	9.5
SPREADSHEETS		
Lotus 1-2-3 for DOS	○ 7.5	○ 8.1
Lotus 1-2-3 (Win 3.x)	○ 7.6	○ 9.3
MS Excel (Win 3.x)	▼ 7.3	○ 9.5
MS Excel (Win 95)	○ 7.6	▼ 11.4
Quattro Pro (Win 3.x)	○ 7.9	▲ 6.7
AVERAGE	7.6	9.0
DATABASES		
Alpha Four (Win 3.x)	○ 7.7	○ 15.5
dBASE (Win 3.x)	○ 7.6	○ 12.6
FoxPro (Win 3.x)	○ 7.2	○ 12.8
Lotus Approach (Win 3.x)	○ 7.8	○ 9.1
MS Access (Win 3.x)	○ 7.3	○ 10.2
MS Access (Win 95)	○ 7.6	○ 11.1
Oracle (Win 3.x)	▼ 6.5	○ 7.8
Paradox (Win 3.x)	○ 7.2	▲ 6.8
Paradox (Win 95)	○ 8.1	▲ 5.3
AVERAGE	7.4	10.1
GRAPHICS APPLICATIONS		
Adobe Illustrator	○ 6.6	○ 16.8
Adobe Photoshop (Win 3.x)	○ 7.7	▼ 9.7
CorelDraw (Win 3.x)	○ 7.3	○ 13.7
CorelDraw (Win 95)	○ 7.1	○ 10.6
Freelance Graphics (Win 3.x)	○ 7.8	○ 8.0
Harvard Graphics (Win 3.x)	○ 7.0	○ 6.4
Micrografx ABC Graphics Suite (Win 95)	○ 7.2	▲ 3.3
MS Publisher (Win 3.x)	○ 7.6	○ 10.6
MS Publisher (Win 95)	○ 7.8	○ 10.6
PageMaker (Win 3.x)	○ 7.1	○ 10.4
PageMaker (Win 95)	○ 7.3	○ 8.3
PowerPoint (Win 3.x)	○ 7.3	○ 8.5
PowerPoint (Win 95)	○ 7.6	▲ 6.8
AVERAGE	7.3	9.6
OSs/ENVIRONMENTS		
MS-DOS	○ 7.3	○ 14.2
MS Windows 3.x	▼ 6.7	○ 13.6
MS Windows 95	○ 7.1	○ 14.8
MS Windows NT	○ 6.9	○ 13.1
OS/2 Warp	▲ 7.9	▲ 9.1
AVERAGE	7.2	13.0
SUITES/INTEGRATED SOFTWARE		
ClarisWorks (Win 3.x)	○ 8.3	▼ 3.0
MS Office (Win 3.x)	○ 7.1	○ 9.4
MS Office (Win 95)	○ 7.5	○ 10.6
MS Works (Win 3.x)	○ 7.2	○ 11.2
MS Works (Win 95)	○ 7.8	○ 8.7
PerfectOffice (Win 3.x)	○ 7.7	○ 19.9
SmartSuite (Win 3.x)	○ 7.2	○ 9.1
SmartSuite (Win 95)	○ 6.9	○ 8.0
AVERAGE	7.5	8.9

likelihood of recommending the product.

Both SmartSuite and Novell's PerfectOffice score worse than average on future likelihood to recommend. Of course, WordPerfect's change of ownership twice in two years might have something to do with its suite's shaky score.

All suites surveyed here receive average scores for technical support, save for Lotus SmartSuite for Windows and Microsoft Office for Windows. The Windows 95 versions of these products fare better. Half of the products receive high marks for vendor support via online services. Microsoft Works for Windows emerges as the only product that earns better-than-average scores for tutorials and written documentation. In the latter area, Microsoft Office for Windows 95 receives a below-average score, but its high marks for built-in help functions may offset that shortcoming.

Except for ClarisWorks, users of all the suites here experience an average of about 9 minutes on hold when calling for technical support. Impressively, ClarisWorks users report that they spend less than half as much waiting time as the users of any other application evaluated here. □

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THE PC MAGAZINE TOP 150 COMPANIES

Another year of nonstop change in the PC industry finds the leading hardware and software vendors still holding sway—most of them, that is. Here's a look at the numbers that make them leaders.

EVERY SERIOUS COMPETITION DEserves a serious scorecard. Because no other industry is as knock-down competitive as the PC industry, once again *PC Magazine* provides financial profiles of the most successful companies in the business. Inside you'll find lists of PC hardware and software companies ranked by 1995 revenues in the categories of PCs, PC servers, software, LAN hardware, printers, monitors, hard disks, and graphics/video boards.

Speaking of 1995, if not for the mind-boggling explosion of Internet developments and the endless hubbub surrounding the introduction of Windows 95, the year was pretty sedate for most of the PC industry's leading hardware and software vendors. In just about every category, last year's leaders are this year's leaders.

Below the top positions, however, the turmoil carries on. Because almost every category is experiencing a continuing consolidation of power in the hands of the industry leaders—often through acquisitions of less-fortunate players—we decided to trim our list to 150 companies from last year's 200 in order to focus on the true champions.

In terms of acquisitions, beyond the one mega-merger that came off—IBM's acquisition of Lotus Development Corp. —the year was justifiably noted for two mergers that did not happen: the Microsoft purchase of Intuit, quashed by Justice Department opposition, and the on-again, off-again deal that would have made Apple a part of Sun Microsystems.

Not that there weren't any changes over the year. Netscape Communications came from nowhere to crack the top ranks of PC software vendors and seems headed up the ladder several rungs per month.

The PCs category continues to be an arena of change as well, with ZEOS making its last appearance as it submerges forever into the organization of its new owner Micron. Zenith Data Systems similarly shifts corporate hats to that of its new owner Packard Bell.

Joining financially troubled Apple to illustrate that sometimes even success doesn't succeed, CompuAdd went out of business in late 1995 even though it ranked in the top 25 of PC sellers. And AT&T's struggling Global Information Solutions branch got a second—or is that third?—lease on life when its parent sent it back out in the world wearing its former NCR label.

In another change, the continuing growth of the client/server computing model persuaded us to add a new category, PC servers. To make room for it, we dropped several of last year's smaller categories. In a more major departure from last year's approach, we worked closely with some of the industry's leading researchers and analysts to bring you data honed by their many years of combined experience. Specifically, this effort owes its success to Soft•letter, the Dell'Oro Group, Dataquest, Stanford Resources, International Data Corp., John Peddie Associates, and Computer Intelligence, all of which partnered with the *PC Magazine* research staff for this compilation.—*Jake Kirchner*

PC Magazine Top 150 Companies

THE PC MAGAZINE 150

Rank	Company (or division)	Address, telephone	URL (http://_____)	U.S. PC revenues 1995 (millions)	Units shipped in U.S., 1995 (thousands)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
PCs								
1	**Apple Computer Inc.**	Cupertino, CA; 800-538-9696, 408-996-1010	www.apple.com	$7,130	2,439	Apple Computer Inc.	Public	$11,378
2	**Compaq Computer Corp.**	Houston, TX; 800-345-1518	www.compaq.com	$6,756	2,832	Compaq Computer Corp.	Public	$14,755
3	**IBM Corp.**	Armonk, NY; 800-772-2227	www.ibm.com	$6,395	2,466	IBM Corp.	Public	$71,940
4	**Packard Bell Electronics Inc.**	Sacramento, CA; 818-865-1555	www.packardbell.com	$5,535	2,548	Packard Bell Electronics Inc.	Private	$4,200
5	**Gateway 2000 Inc.**	North Sioux City, SD; 800-846-2000, 605-232-2000	www.gw2k.com	$3,523	1,162	Gateway 2000 Inc.	Public	$3,676
6	**Dell Computer Corp.**	Austin, TX; 800-289-3355, 512-338-4400	www.dell.com	$2,883	1,242	Dell Computer Corp.	Public	$5,296
7	**Hewlett-Packard Co.**	Palo Alto, CA; 800-752-0900	www.hp.com	$2,315	744	Hewlett-Packard Co.	Public	$33,500
8	**Toshiba America Information Systems Inc., Computer Division**	Irvine, CA; 800-334-3445, 714-583-3000	www.tais.com	$2,195	626	Toshiba Corp.	Public	$52,000*
9	**NEC Technologies Inc.**	Boxborough, MA; 800-632-4636, 508-264-8000	www.nec.com	$2,144	687	NEC Corp.	Public	$36,710*
10	**AST Computer**	Irvine, CA; 800-876-4278, 714-727-4141	www.ast.com	$1,871	687	AST Research Inc.	Public	$2,348
11	**Digital Equipment Corp., Personal Computer Business Unit**	Acton, MA; 800-344-4825, 508-493-5991	www.pc.digital.com	$1,718	596	Digital Equipment Corp.	Public	$14,440
12	**Acer America Corp.**	San Jose, CA; 800-733-2237, 408-432-6200	www.acer.com	$1,670	623	Acer Inc.	Public	$5,700
13	**AT&T Global Information Solutions** (now NCR Computer Systems Group)	Dayton, OH; 800-447-1124, 513-445-5000	www.ncr.com	$1,581	496	AT&T Corp. (now NCR Corp.)	Public	$79,609
14	**Epson America Inc.**	Torrance, CA; 800-289-3776, 310-782-0770	www.epson.com	$863	241	Seiko Epson Corp.	Private	$4,970*
15	**Zenith Data Systems Corp.** (acquired by Packard Bell Electronics Inc.)	Buffalo Grove, IL; 800-533-0331, 847-808-5000	www.zds.com	$358	151	Groupe Bull	Public	$4,200
16	**Leading Edge Products Inc.** (acquired by Manuhold Investment AG)	Westborough, MA; 508-562-3322	None	$295	101	Daewoo Corp.	Private	$1,000
17	**Texas Instruments Inc., Personal Productivity Products**	Temple, Texas; 800-848-3927, 817-771-5856	www.ti.com	$230	91	Texas Instruments Inc.	Public	$13,128
18	**Power Computing Corp.**	Round Rock, Texas; 800-370-7693, 512-246-7807	www.powercc.com	$200	63	Power Computing Corp.	Private	$225*
19	**Micron Electronics Inc.**	Nampa, ID; 800-438-3343, 208-893-3434	www.micron.com	$190	112	Micron Technology Inc.	Public	$3,604
20	**Siemens Nixdorf**	Burlington, MA; 800-225-1484, 617-273-0480	www.sni.de	$179	50	Siemens AG	Public	$60,206*
21	**ZEOS International Ltd.** (merged into Micron Electronics Inc.)	Nampa, ID; 800-438-3343, 208-893-3434	www.micron.com	$177	77	Micron Technology Inc.	Public	$3,604
22	**Olivetti North America**	Liberty Lake, WA; 800-633-9909, 509-927-5600	www.olivetti.com	$133	23	Ing. C. Olivetti & C., S.p.A.	Public	$6,048
23	**Unisys Corp.**	San Jose, CA; 800-874-8647, 716-742-6780	www.unisys.com	$105	60	Unisys Corp.	Public	$6,202
24	**Advanced Logic Research Inc.**	Irvine, CA; 800-444-4257, 714-581-6770	www.alr.com	$101	31	Advanced Logic Research Inc.	Public	$204
25	**DTK Computer Inc.**	City of Industry, CA; 800-289-2385, 818-810-0098	www.dtk.com	$95	35	DTK Computer Inc.	Private	$250
PC SERVERS								
1	**Compaq Computer Corp.**	Houston, TX; 800-345-1518	www.compaq.com	$3,146	295	Compaq Computer Corp.	Public	$14,755
2	**IBM Corp.**	Armonk, NY; 800-772-2227	www.ibm.com	$2,140	120	IBM Corp.	Public	$71,940
3	**Dell Computer Corp.**	Austin, TX; 800-289-3355, 512-338-4400	www.dell.com	$801	45	Dell Computer Corp.	Public	$5,296
4	**Hewlett-Packard Co.**	Palo Alto, CA; 800-752-0900	www.hp.com	$597	42	Hewlett-Packard Co.	Public	$33,500
5	**Digital Equipment Corp., Personal Computer Business Unit**	Acton, MA; 800-344-4825, 508-493-5991	www.pc.digital.com	$532	51	Digital Equipment Corp	Public	$14,440
6	**AT&T Global Information Solutions** (now NCR Computer Systems Group)	Dayton, OH; 800-447-1124, 513-445-5000	www.ncr.com	$352	11	AT&T Corp. (now NCR Corp.)	Public	$79,609
7	**Apple Computer Inc.**	Cupertino, CA; 800-538-9696, 408-996-1010	www.apple.com	$181	23	Apple Computer Inc.	Public	$11,378

* Estimated.

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THE PC MAGAZINE 150

Rank	Company (or division)	Address, telephone	URL (http://_____)	U.S. PC revenues 1995 (millions)	Units shipped in U.S., 1995 (thousands)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
8	**AST Computer**	Irvine, CA; 800-876-4278, 714-727-4141	www.ast.com	$166	12	AST Research Inc.	Public	$2,348
9	**Unisys Corp.**	San Jose, CA; 800-874-8647, 408-434-2848	www.unisys.com	$115	7	Unisys Corp.	Public	$6,202
10	**Zenith Data Systems Corp.** (acquired by Packard Bell Electronics Inc.)	Buffalo Grove, IL; 800-533-0331, 847-808-5000	www.zds.com	$86	7	Groupe Bull	Public	$4,200

Rank	Company (or division)	Address, telephone	URL (http://_____)	Worldwide PC software revenues, 1995 (millions)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
PC SOFTWARE							
1	**Microsoft Corp.**	Redmond, WA; 206-882-8080	www.microsoft.com	$7,420	Microsoft Corp.	Public	$7,420
2	**Novell Inc.**	Orem, UT; 800-453-1267, 801-222-6000	www.novell.com	$1,902	Novell Inc.	Public	$1,902
3	**IBM Corp.**	Armonk, NY; 800-772-2227	www.ibm.com	$1,500*	IBM Corp.	Public	$71,940
4	**Adobe Systems Inc.**	Mountain View, CA; 415-961-4400	www.adobe.com	$762	Adobe Systems Inc.	Public	762
5	**Autodesk Inc.**	San Rafael, CA; 415-507-5000	www.autodesk.com	$534	Autodesk Inc.	Public	$534
6	**Intuit Inc.**	Mountain View, CA; 415-944-6000	www.intuit.com	$503	Intuit Inc.	Public	$503
7	**Symantec Corp.**	Cupertino, CA; 408-253-9600	www.symantec.com	$438	Symantec Corp.	Public	$438
8	**Attachmate Corp.**	Bellevue, CA; 800-426-6283, 206-644-4010	www.atm.com	$415	Attachmate Corp.	Private	$415
9	**Oracle Corp.**	Redwood Shores, CA; 415-506-7000	www.oracle.com	$322	Oracle Corp.	Public	$3,479
10	**SoftKey International Inc.**	Cambridge, MA; 617-494-1200	www.softkey.com	$255	SoftKey International Inc.	Public	$255
11	**Sybase Inc.**	Emeryville, CA; 510-922-3500	www.sybase.com	$228	Sybase Inc.	Public	$957
12	**Quark Inc.**	Denver, CO; 303-894-8888	www.quark.com	$225*	Quark Inc.	Private	$225*
13	**GT Interactive Software Corp.**	New York, NY; 212-726-6500	www.gtinteractive.com	$204	GT Interactive Software Corp.	Public	$204
14	**Santa Cruz Operation Inc.**	Santa Cruz, CA; 408-425-7222	www.sco.com	$199	Santa Cruz Operation Inc.	Public	$199
15	**Corel Corp.**	Ottawa, Ontario, Canada; 613-728-8200	www.corel.ca	$196	Corel Corp.	Public	$196
16	**Broderbund Software Inc.**	Novato, CA; 415-382-4400	www.broder.com	$190	Broderbund Software Inc.	Public	$190
17	**Claris Corp.**	Santa Clara, CA; 800-325-2747, 408-727-8227	www.claris.com	$184	Apple Computer Co.	Public	$11,378
18	**Digital Equipment Corp.**	Maynard, MA; 800-344-4825, 508-493-5111	www.digital.com	$175*	Digital Equipment Corp.	Public	$14,440
19	**Cheyenne Software Inc.**	Roslyn Heights, NY; 516-465-4000	www.cheyenne.com	$158	Cheyenne Software Inc.	Public	$158
20	**Davidson & Associates Inc.** (acquired by CUC International Inc.)	Torrance, CA; 310-793-0600	www.davd.com	$147	Davidson & Associates Inc.	Public	$147
21	**Sierra On-Line Inc.** (acquired by CUC International Inc.)	Bellevue, WA; 206-649-9800	www.sierra.com	$145	Sierra On-Line Inc.	Public	$145
22	**FTP Software Inc.**	Andover, MA; 800-382-4387, 508-685-4000	www.ftp.com	$136	FTP Software Inc.	Public	$136
23	**NetManage Inc.**	Cupertino, CA; 408-973-7171	wwww.netmanage.com	$125	NetManage Inc.	Public	$125
24	**Computer Associates Inc.**	Islandia, NY; 800-225-5224, 516-342-5224	www.cai.com	$125	Computer Associates Inc.	Public	$3,198
25	**Walker Richer & Quinn Inc.**	Seattle, WA; 800-872-2829, 206-217-7500	www.wrq.com	$112	Walker Richer & Quinn Inc.	Private	$112
26	**Wall Data Inc.**	Kirkland, WA; 800-487-8622, 206-814-9255	www.walldata.com	$111	Wall Data Inc.	Public	$111

* Estimated.

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Home PC, in the April '96 issue, included the 17GA in their Top 100 Hardware Products.

MacUser magazine, in their December '95 issue, named the 17GA its Best Buy and in their March '96 issue, gave the 15GA a coveted Four Mice rating.

Windows magazine, in their December '95 and April '96 issues, "recommended" the 17GA.

February '96 issue of PC Graphics and Video "Highly Recommended" the 17GA.

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Model	15GA	17GA
CRT Size	15" (14.0" viewable)	17" (16.0" viewable)
Dot Pitch	0.27mm	0.27 mm
Max. Resolution	1280 x 1024	1280 x 1024
Recommended Resolution	1024 x 768 @ 85 Hz	1024 x 768 @ 85 Hz
Integrated Spkrs./Mic.	Yes	Yes
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CIRCLE 118 ON READER SERVICE CARD

PC Magazine Top 150 Companies

THE PC MAGAZINE 150

Rank	Company (or division)	Address, telephone	URL (http://_____)	Worldwide PC software revenues, 1995 (millions)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
27	**Informix Software Inc.**	Menlo Park, CA; 800-331-1763, 415-926-6300	www.informix.com	$106	Informix Software Inc.	Public	$709
28	**Interplay Productions Inc.**	Irvine, CA; 714-553-6655	www.interplay.com	$100	Interplay Productions Inc.	Private	$100
29	**Macromedia Inc.**	San Francisco, CA; 800-888-9335, 415-252-2000	www.macromedia.com	$97	Macromedia Inc.	Public	$97
30	**Bentley Systems Inc.**	Exton, PA; 800-236-8539, 610-458-5000	www.bentley.com	$95	Bentley Systems Inc.	Private	$95
31	**Quarterdeck Corp.**	Marina Del Ray, CA; 800-354-2834, 310-309-3700	www.quarterdeck.com	$93	Quarterdeck Corp.	Public	$93
32	**McAfee Associates**	Santa Clara, CA; 888-847-8766, 408-988-3832	www.mcafee.com	$90	McAfee Associates Inc.	Public	$90
33	**Netscape Communications Corp.**	Mountain View, CA; 415-254-1900	www.netscape.com	$81	Netscape Communications Corp.	Public	$81
34	**Micrografx Inc.**	Richardson, TX; 214-234-1769	www.micrografx.com	$64	Micrografx Inc.	Public	$64
35	**SPSS Inc.**	Chicago, IL; 312-329-2400	www.spss.com	$63	SPSS Inc.	Public	$63
36	**Spectrum HoloByte Inc.**	Alameda, CA; 510-522-3584	www.holobyte.com	$57	Spectrum HoloByte Inc.	Public	$57
37	**Platinum Software Corp.**	Irvine, CA; 800-999-1809, 714-453-4000	www.platsoft.com	$56	Platinum Software Corp.	Public	$56
38	**Insignia Solutions Inc.**	Santa Clara, CA; 408-327-6000	www.insignia.com	$55	Insignia Solutions Inc.	Public	$55
39	**Phoenix Technologies Ltd.**	Santa Clara, CA; 800-677-7305, 408-654-9000	www.ptltd.com	$53	Phoenix Technologies Ltd.	Public	$53
40	**Maxis Inc.**	Walnut Creek, CA; 510-933-5630	www.maxis.com	$52	Maxis Inc.	Public	$52
41	**Caere Corp.**	Los Gatos, CA; 408-395-7000	www.caere.com	$52	Caere Corp.	Public	$52
42	**Connectix Corp.**	San Mateo, CA; 800-950-5880, 415-571-5100	www.connectix.com	$48	Connectix Corp.	Private	$48
43	**Stac Electronics**	San Diego, CA; 619-794-4300	www.stac.com	$46	Stac Inc.	Public	$46
44	**Activision Inc.**	Los Angeles, CA; 310-473-9200	www.activision.com	$46	Activision Inc.	Public	$46
45	**State of the Art Inc.**	Irvine, CA; 800-854-3415, 714-753-1222	www.stateoftheart.com	$46	State of the Art Inc.	Public	$46
46	**ON Technology Corp.**	Cambridge, MA; 800-767-6683, 617-374-1400	www.on.com	$44	ON Technology Corp.	Public	$44
47	**INSO Corp.**	Boston, MA; 617-753-6500	www.inso.com	$43	INSO Corp.	Public	$43
48	**MapInfo Corp.**	Troy, NY; 518-285-6000	www.mapinfo.com	$41	MapInfo Corp.	Public	$41
49	**Visio Corp.**	Seattle, WA; 206-521-4500	www.visio.com	$39	Visio Corp.	Public	$39
50	**Datastorm Technologies Inc.** (acquired by Quarterdeck Corp.)	Columbia, MO; 573-443-3282	www.datastorm.com	$39	Datastorm Technologies Inc.	Private	$39
51	**Best Programs Inc.**	Reston, VA; 703-709-5200	www.bestprograms.com	$38	Best Programs Inc.	Private	$38
52	**Softdesk Inc.**	Henniker, NY; 603-428-5000	www.softdesk.com	$36	Softdesk Inc.	Public	$36
53	**XcelleNet Inc.**	Atlanta, GA; 770-804-8100	www.xcellenet.com	$34	XcelleNet Inc.	Public	$34
54	**MECC**	Minneapolis, MN; 800-685-6322, 612-569-1500	www.mecc.com	$34	MECC (Minnesota Educational Computing Corp.)	Public	$34
55	**Edmark Corp.**	Redmond, WA; 206-556-8400	www.edmark.com	$32	Edmark Corp.	Public	$32
56	**Peachtree Software Inc.**	Norcross, GA; 770-564-5700	www.peach.com	$32	Automatic Data Processing Inc.	Public	$3,166
57	**Primavera Systems Inc.**	Bala Cynwyd, PA; 610-667-8600	www.primavera.com	$30	Primavera Systems Inc.	Private	$30

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CIRCLE 036 ON READER SERVICE CARD

THE PC MAGAZINE 150

Rank	Company (or division)	Address, telephone	URL (http://_____)	Worldwide PC software revenues, 1995 (millions)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
58	**Expert Software**	Coral Gables, FL; 305-567-9990	*www.expertsoftware.com*	$28	Expert Software	Public	$28
59	**Timberline Software Corp.**	Beaverton, OR; 503-626-6775	None	$25	Timberline Software Corp.	Public	$25
60	**SystemSoft Corp.**	Natick, MA; 800-449-7973, 508-651-0088	*www.systemsoft.com*	$25	SystemSoft Corp.	Public	$25
61	**Software Publishing Corp.**	San Jose, CA; 408-537-3000	*www.spco.com*	$24	Software Publishing Corp.	Public	$24
62	**Living Books**	San Francisco, CA; 415-352-5200	*www.broder.com*	$24	Random House/ Broderbund	Joint Venture	$24
63	**Traveling Software Inc.**	Bothell, WA; 206-483-8088	*www.travsoft.com*	$23	Traveling Software Inc.	Private	$23
64	**IQ Software Corp.**	Norcross, GA; 800-458-0386, 404-446-8880	*www.iqsc.com*	$22	IQ Software Corp.	Public	$22
65	**Pro CD Inc.** (acquired by Acxiom Corp.)	Danvers, MA; 508-750-0000	*www.procd.com*	$22	Pro CD Inc.	Private	$22
66	**IMSI**	San Rafael, CA; 415-257-3000	*www.imsisoft.com*	$21	IMSI (International Microcomputer Software Inc.)	Public	$21
67	**Asymetrix Corp.**	Bellevue, WA; 800-448-6523, 206-462-0501	*www.asymetrix.com*	$20	Asymetrix Corp.	Private	$20
68	**Systems Plus Inc.**	Mountain View, CA; 800-222-7701, 415-969-7047	*www.systemsplus.com*	$20	Systems Plus Inc.	Private	$20
69	**Persoft Inc.**	Madison, WI; 608-273-6000	*www.persoft.com*	$19	Persoft Inc.	Private	$19
70	**Eagle Point Software Corp.**	Dubuque, IA; 319-556-8392	*www.netins.net/ showcase/eaglewww/*	$19	Eagle Point Software Corp.	Public	$19

Rank	Company (or division)	Address, telephone	URL (http://_____)	Worldwide LAN hardware revenues, 1995 (millions)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
LAN HARDWARE							
1	**Cisco Systems Inc.**	San Jose, CA; 800-326-1941, 408-526-4000	*www.cisco.com*	$2,667	Cisco Systems Inc.	Public	$2,667
2	**Bay Networks Inc.**	Santa Clara, CA; 408-988-2400	*www.baynetworks.com*	$1,727	Bay Networks Inc.	Public	$1,727
3	**3Com Corp.**	Santa Clara, CA; 408-764-5000	*www.3com.com*	$1,717	3Com Corp.	Public	$1,717
4	**IBM Corp., Networking Hardware Division**	Research Triangle Park, NC; 800-426-2255	*www.ibm.com*	$1,260*	IBM Corp.	Public	$71,940
5	**U.S. Robotics Corp.**	Skokie, IL; 708-982-5010	*www.usr.com*	$1,092	U.S. Robotics Corp.	Public	$1,092
6	**Cabletron Systems Inc.**	Rochester, NH; 800-332-9401, 603-332-9400	*www.cabletron.com*	$1,000	Cabletron Systems Inc.	Public	$1,000
7	**Digital Equipment Corp., Network Product Business**	Littleton, MA; 800-457-8211, 508-692-2562	*www.networks.digital.com*	$590*	Digital Equipment Corp.	Public	$14,440
8	**Hewlett-Packard Co., Workgroup NetWorks Division**	Roseville, CA; 800-533-1333	*www.hp.com*	$410*	Hewlett-Packard Co.	Public	$33,500
9	**Madge Networks Inc.**	San Jose, CA; 800-876-2343, 408-955-0700	*www.madge.com*	$402	Madge Networks Inc.	Public	$402
10	**UB Networks Inc.**	Santa Clara, CA; 408-496-0111	*www.ub.com*	$225*	Tandem Computers Inc.	Public	$2,262
11	**Standard Microsystems Corp.**	Hauppauge, NY; 516-435-6000	*www.smc.com*	$201	Standard Microsystems Corp.	Public	$350
12	**Ascend Communications Inc.**	Alameda, CA; 800-272-3634, 510-769-6001	*www.ascend.com*	$150	Ascend Communications Inc.	Public	$150
13	**Fore Systems Inc.**	Warrendale, PA; 412-772-6600	*www.fore.com*	$145	Fore Systems Inc.	Public	$145
14	**Microcom Inc.**	Norwood, MA; 800-822-8224, 617-551-1000	*www.microcom.com*	$127	Microcom Inc.	Public	$127
15	**Shiva Corp.**	Bedford, MA; 800-977-4482, 617-270-8300	*www.shiva.com*	$94	Shiva Corp.	Public	$94

* Estimated.

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CIRCLE 154 ON READER SERVICE CARD

PC Magazine Top 150 Companies

THE PC MAGAZINE 150

Rank	Company (or division)	Address, telephone	URL (http://_____)	U.S. revenues 1995 (millions)	Units shipped in U.S., 1995 (thousands)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
PRINTERS								
1	**Hewlett-Packard Co.**	Palo Alto, CA; 800-752-0900	www.hp.com	$4,365	6,944	Hewlett-Packard Co.	Public	$33,500
2	**Canon Computer Systems Inc.**	Costa Mesa, CA; 800-848-4123, 714-438-3391	www.canon.com	$962	2,744	Canon Inc.	Public	$21,000
3	**Epson America Inc.**	Torrance, CA; 800-289-3776, 310-782-0770	www.epson.com	$787	1,775	Seiko Epson Corp.	Private	$4,970*
4	**Apple Computer Inc., Apple America's Division**	Cupertino, CA; 800-538-9696, 408-996-1010	www.apple.com	$509	815	Apple Computer Inc.	Public	$11,378
5	**Lexmark International Inc.**	Greenwich, CT; 800-358-5835, 606-232-2000	www.lexmark.com	$437	664	Lexmark International Inc.	Public	$2,200
6	**Okidata**	Mount Laurel, NJ; 800-654-8326, 609-235-2600	www.okidata.com	$351	812	Oki Electric Industry Co., Ltd.	Public	$6,560*
7	**Panasonic Communications & Systems Co.**	Secaucus, NJ; 800-742-8086, 201-348-7000	www.panasonic.com	$138	536	Matsushita Electric Industrial Co., Ltd	Public	$68,346*
8	**Digital Equipment Corp.**	Maynard, MA; 800-344-4825, 508-493-5111	www.digital.com	$130	323	Digital Equipment Corp.	Public	$14,440
9	**Brother International Corp.**	Somerset, NJ; 800-276-7746, 908-356-8800	www.brother.com	$106	232	Brother Industries Ltd.	Private	$2,020*
10	**Tektronix Inc.**	Wilsonville, OR; 800-835-6100, 503-627-7111	www.tek.com	$105	22	Tektronix Inc.	Public	$1,670
MONITORS								
1	**NEC Technologies Inc., MultiSync Display Division**	Itasca, IL; 800-632-4636, 708-775-7900	www.nec.com	$745	1,114	NEC Corp.	Public	$36,710*
2	**Sony Electronics Inc., Information Technology of America**	San Jose, CA; 800-352-7669, 408-432-0190	www.sony.com	$730	1,162	Sony Corp.	Public	$42,000
3	**Samsung Electronics America, Information Media Division**	Ridgefield Park, NJ; 800-933-4110, 201-619-8200	www.samsung.com	$728	3,072	Samsung Group	Public	$83,800*

* Estimated.

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CIRCLE 196 ON READER SERVICE CARD

PC Magazine Top 150 Companies

THE PC MAGAZINE 150

Rank	Company (or division)	Address, telephone	URL (http://_____)	U.S. revenues 1995 (millions)	Units shipped in U.S., 1995 (thousands)	Parent company	Ownership of parent company	Parent company's revenues 1995 (millions)
4	**Philips Consumer Electronics Co.**	Knoxville, TN; 800-835-3506, 423-521-4316	www.philips.com	$651	2,205	Philips Electronics N.V.	Public	$40,000
5	**ADI Systems Inc.**	San Jose, CA; 800-228-0530, 408-944-0100	www.adi-online.com	$548	1,512	ADI Corp.	Public	$696
6	**LG Electronics U.S.A. Inc.**	Englewood Cliffs, NJ; 800-243-0000, 201-816-2000	www.lgeus.com	$507	2,108	LG Group	Public	$79,051*
7	**Acer Peripherals Inc.**	Taipei, Taiwan; 800-733-2237, 408-432-6200	www.acer.com	$440	1,785	Acer Inc.	Public	$5,700
8	**MAG InnoVision**	Santa Anna, CA; 800-827-3998, 714-751-2008	www.maginnovision.com	$379	938	MAG Innovision Co. Inc.	Private	$411
9	**CTX International Inc.**	City of Industry, CA; 800-888-2012, 818-839-0500	www.ctxintl.com	$305	805	Chuntex Electronic Co., Ltd.	Public	$550
10	**Tatung Company of America**	Long Beach, CA; 800-827-2850, 213-979-7055	www.tatung.com	$295	1,375	Tatung Co.	Public	$3,500
HARD DISKS								
1	**Seagate Technology Inc.**	Scotts Valley,CA; 408-438-6550	www.seagate.com	$3,177	9,133	Seagate Technology Inc.	Public	$5,500
2	**Quantum Corp.**	Milpitas, CA; 800-624-5545, 408-894-4000	www.quantum.com	$2,121	8,630	Quantum Corp.	Public	$4,174
3	**IBM Corp.**	Armonk, NY; 800-772-2227	www.ibm.com	$1,450	6,115	IBM Corp.	Public	$71,940
4	**Western Digital Corp.**	Irvine, CA; 800-832-4778, 714-932-5000	www.wdc.com	$1,279	5,485	Western Digital Corp.	Public	$2,430
5	**Conner Peripherals Inc.** (acquired by Seagate Technology Inc.)	Scotts Valley, CA; 408-438-6550	www.seagate.com	$1,240	5,398	Conner Peripherals Inc.	Public	$5,493
GRAPHICS/VIDEO BOARDS								
1	**Diamond Multimedia Systems Inc., Visual Systems Division**	San Jose, CA; 800-468-5846, 408-325-7000	www.diamondmm.com	$227	1,695	Diamond Multimedia Systems Inc.	Public	$488
2	**ATI Technologies Inc.**	Thornhill, Ontario; 905-882-2600	www.atitech.ca	$147	751	ATI Technologies Inc.	Public	$273
3	**Matrox Graphics Inc.**	Dorval, Quebec; 800-361-1408, 514-969-6300	www.matrox.com	$123*	500*	Matrox Electronic Systems Ltd.	Private	$200*
4	**STB Systems Inc.**	Richardson, TX; 214-234-8750	www.stb.com	$99	600*	STB Systems Inc.	Public	$141
5	**Number Nine Visual Technology Corp.**	Lexington, MA; 800-438-6463, 617-674-0009	www.nine.com	$82	458	Number Nine Visual Technology Corp.	Public	$116

* Estimated.

METHODOLOGY

We gathered the data for this compilation in April. The basic information for each category (leading companies, their revenues per category and—where included—numbers of units shipped in that category) was provided by research organizations specializing in coverage of these product areas. Specifically, we relied upon information provided by Soft•letter (PC software), the Dell'Oro Group (LAN hardware), Stanford Resources (monitors), Dataquest (hard disks), International Data Corp. and John Peddie Associates (graphics/video boards), and Computer Intelligence (PCs, PC servers, and printers).

Because there are significant differences among the PC industry's various market segments, the types of data varied among product categories. For some categories we captured U.S. revenues; for others we gathered worldwide revenues. Although we emphasized U.S. sales in most categories, we also included non-U.S. vendors with significant U.S. market share. For large, diversified companies such as IBM, Digital, Hewlett-Packard, and Apple, we attempted to isolate data for specific divisions. In every instance we relied upon the experts noted above to suggest appropriate ways to gather and report data on the companies included here.

We then acquired additional data on each company included in these charts: its location, telephone numbers, World Wide Web address, and its corporate parent's annual revenues. In most instances that information came directly from each company or from company documents publicly available (annual reports, Securities and Exchange Commission filings, press releases, and Web pages). In every instance we tried to confirm all data with the companies covered.

In order to ensure comparability among the companies within each category, we used units-shipped and financial data for calendar 1995. If a company's fiscal year ended anywhere from November 30, 1995, to January 31, 1996, we accepted it as equivalent to the calendar year 1995. For companies whose fiscal years ended outside that two-month period we gathered data by individual quarters in 1995 to determine total numbers for calendar 1995. All revenue figures are in U.S. dollars. Where necessary we calculated U.S. dollar amounts for non-U.S. companies using exchange rates in effect at the end of April.

In a few cases exact information was unavailable (particularly for private companies and for companies that do not break out data along the lines required for this project). In those instances we turned to outside analysts, particularly representatives of the data sources cited above and Jardine Fleming Securities, Tokyo (for data on Pacific Rim companies), and various corporate directories. Any number that could not be directly verified by a company is noted as "estimated" in the charts.

Our Contributors: JAKE KIRCHNER is the editor of *PC Magazine*. The data for the *PC Magazine* 150 was compiled under the direction of JUDY DEYOUNG, editorial resesearch manager; by editorial researchers ROBERT DALY, DAVID FRANK, JOSH LEVY, ARIE MOLLER, and RICHARD S. SHIM; and by NANCY SIRAPYAN, editorial librarian, and RITA APRAHAMIAN, assistant to the editor.

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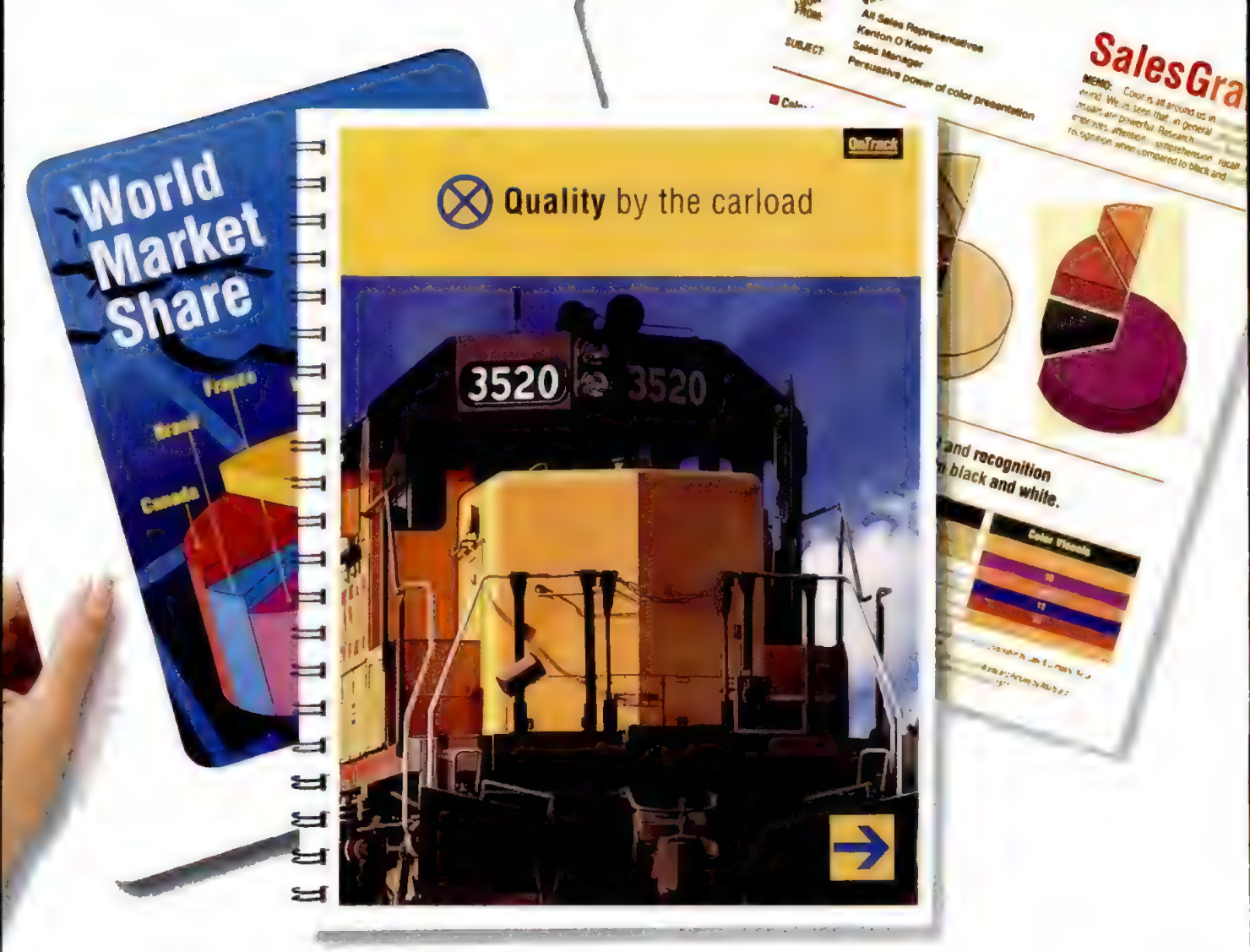
CIRCLE 303 ON READER SERVICE CARD



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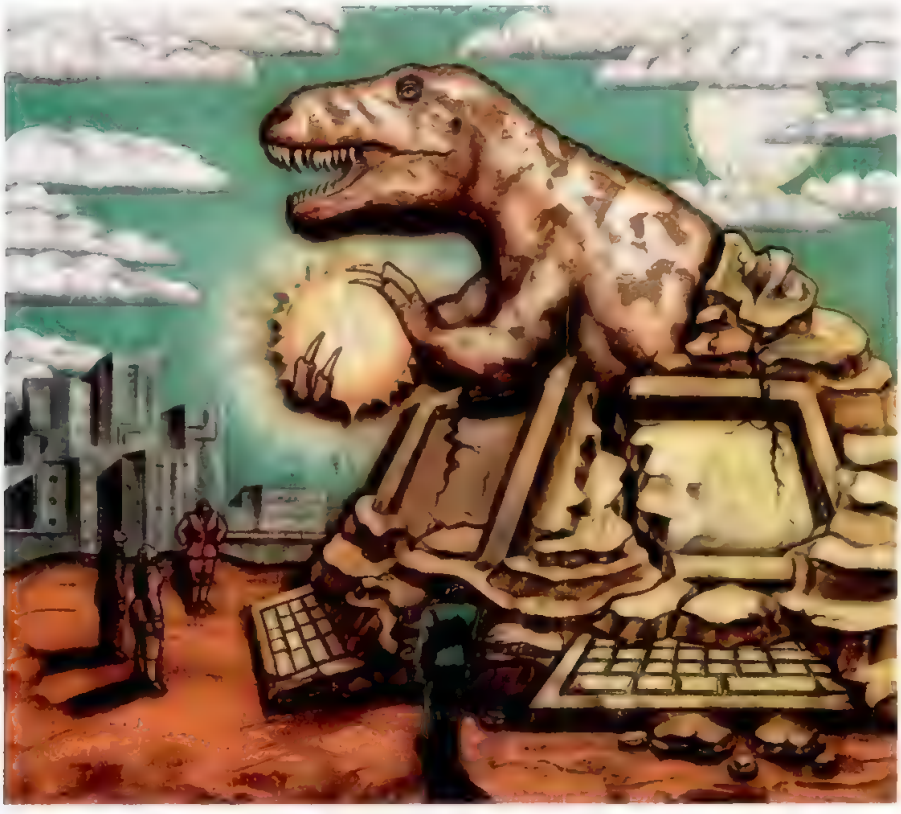

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Visual REXX Tools

Three strong contenders let you build powerful OS/2 applications.

By Gabrielle Gagnon

REXX has come a long way since its infancy as an interpreted mainframe procedure language. A veteran of the big-iron glory days probably wouldn't even recognize the new REXX, so much has changed. REXX applications of the '90s are compiled, modularized, objectized, data-aware dynamos that sport OOUI-GUI interfaces and speak in multimedia tongues.

The products in this review, Apical Software's Gpf Rexx, Hockware's VisPro/REXX, and Sybase's Watcom VX-REXX, have helped the new incarnation of REXX come of age on the OS/2 desktop. And though they share many similarities, each product represents a distinct trend in the types of applications being built in REXX today.

Gpf Rexx has particularly strong multimedia support, VX-REXX

IN THIS SECTION

INSIDE WINDOWS 95 You may not even know about it, but there's a partial update to Windows 95 called Service Pack 1. It includes new components, updated drivers, tools for system administrators, plus fixes to some minor bugs. Find out what you could gain by acquiring Service Pack 1. *page 273*

INTERNET TOOLS A lot of Web surfing is done not by humans but by other creatures. Jeff Prosise explains how spiders, robots, wanderers, walkers, and agents crawl the Web, how you can get started writing a spider, and how you can prepare your Web site for an invasion by these critters. *page 277*

POWER PROGRAMMING Microsoft's new DirectDraw API, part of the game SDK, gives programmers low-level access to the accelerated video cards that are becoming more and more popular on PCs. In this column, we show you how to program using DirectDraw and C++. *page 281*

INSIDE OS/2 Last time in Inside OS/2, we created a REXX-based CD player. We continue to explore multimedia possibilities using REXX for OS/2, creating an audio effects application and a jukebox that can play MIDI, movie, wave, and CD-audio data. *page 291*

UTILITIES Windows 95 includes an Add/Remove Programs feature in the Control Panel, but this only works for well-behaved programs. Our new 32-bit version of the popular InCtrl utility knows about the Registry and long filenames. Use it to help you install uncooperative programs intelligently. *page 307*

ALSO IN THIS ISSUE In PC Solutions, we tell you how to create secure user profiles with Windows 95's Policy Editor, explain how to connect three or four floppy disk drives to a single system, present ways to get optimum performance on your Pentium if you're running OS/2 Warp, and more. *page 357*

pioneered database connectivity, and VisPro/REXX is going further in that direction with entity-relationship modeling and reverse engineering. Now, with VisPro/REXX venturing into team development and version control, it looks as though these products may take REXX full circle—right back to IS and its mainframe surrogate: enterprisewide client/server computing.

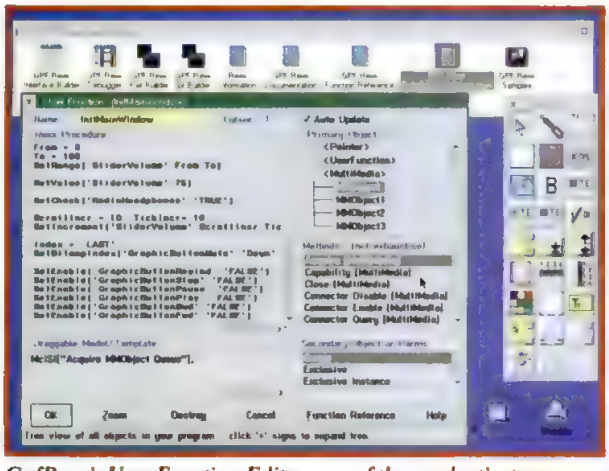
Apical Software Inc.

Gpf Rexx

The first product we looked at was Apical Software's Gpf Rexx, Version 2.1, priced at $199—$100 dollars less than the other two, but almost equal in functionality. Where this development environment falls short of the others is in ease of use and productivity aids.

Gpf Rexx seems to follow the old-school philosophy that developers are Spartans who don't want much help and would rather hack things out for themselves. There's not much documentation besides the terse Function Reference listings. Still, the package does ship with over 40 sample applications—more than any of the other products—so if you don't mind digging for information, you can probably figure out what you need to know from looking at those. Samples range from simple illustrations of specific controls (Sample ListBox, Sample Slider) to complex communications (EHLLAPI, CPI-C File Server, CPI-C File Requester).

Of the three packages, Gpf Rexx is the one most geared to professional developers, since it has standard options for fairly low-level interface control. When defining a menu, for example, you can select whether or not the application should be responsible for drawing, redrawing, and dismissing the menu (a feature called Owner Redraw), or whether these operations should occur automatically. There are also a number of options, such as SyncPaint and NoByteAligned, for improving performance. Turning on the SyncPaint option sends paint messages to an object immediately—whenever part of the screen needs repainting—and turning it off gives other window messages higher priority, making the window take longer to display. Setting the NoByteAligned option off aligns the window on an 8-byte memory boundary for faster access. Power users might shrug their shoulders at these kinds of options, but professional developers like having them.



GpfRexx's User Function Editor, one of the product's strong points, helps you build custom REXX functions.

Compared with the other products, Gpf Rexx's screen painter is the most cumbersome to use. It allows little direct manipulation of objects and utilizes no pop-up menus or similar shortcuts. (Pop-up menus and accelerator keys can be incorporated into Gpf Rexx applications, however.) Developers must spend a lot of time navigating through hierarchies of modal dialog boxes to set object properties and behavior. While modal dialogs keep you focused on completing the task at hand, they also make it inconvenient to experiment or to begin a related task, since you have to back out of whatever you're doing to start something different.

If you were constructing a notebook object, for example, and you wanted to add a routine to initialize variables on one of the pages, you would have to go through five dialog boxes to get to the section for attaching the appropriate code. If none of the predefined functions (displayed in a list box) suited your needs, you would have to back out of all five dialogs to return to the menu bar. Then, since there are no accelerator keys, you would have to pull down the Objects menu and select User Functions to call up two more modal dialogs to create the function. Once the function was saved, you'd have to dismiss each of those dialogs to return to the notebook, then go back through the original five dialogs to select your newly defined function from the list box.

This can get very tedious after a while. You'd need to write custom code in advance to be efficient. (By contrast, you can add an impromptu initialization routine to a notebook in VX-REXX in one step.) Also, Gpf Rexx's screen painter doesn't use the OS/2 clipboard, so you can't copy any controls to save time in sizing or configuring similar objects. This is not the most productive environment in which to develop GUI interfaces.

On the plus side, however, Gpf Rexx's User Function Editor, used for writing custom REXX functions, is much better designed than its screen painter. The User Function Editor as well as all REXX code are internal to Gpf Rexx, so you cannot read from or write to external REXX programs directly. But, you can transfer code indirectly via the OS/2 clipboard. (Even though the clipboard is not active in the screen painter itself, it is enabled in the dialog boxes.)

The User Function Editor's dialog box is divided into five panels, with a row of push buttons along the bottom of the window for saving, canceling, and so on. You enter the actual code in the largest panel on the left. On the right, another panel contains a hierarchical tree view of all the objects in the application for your reference. As you drill down and click on various objects in this panel, a context-sensitive list of methods appropriate to the highlighted object appears in the panel immediately below the object list. Selecting one of those methods will display secondary objects (or objects used as parameters) in a third panel beneath the methods box and will

Watcom VX-REXX 2.1D, Client/Server Edition

A tough call, given that each product has its particular strengths, but VX-REXX, from Sybase, is the Editors' Choice for the best overall environment for developing REXX applications. Its broad range of configuration options, easy maintenance, interoperability, and varied Help facilities make it hard to beat as a deployment environment, and its ease of use is unsurpassed. As a database front end, its ability to combine multiple data sources and queries in a single window also gives it a distinct advantage over its competition for client/server development. VX-REXX is one of the most productive environments we've found, and best of all, it's just plain fun to work with.

VisPro/REXX deserves an honorable mention for expanding REXX's horizons through innovative features. The introduction of ER diagrams, reverse-engineering, and rudimentary version control to what was once a simple procedure language hints at transforming REXX yet again—this time from a humble GUI interface builder to a serious data-modeling and team-development tool. VisPro/REXX outpaces its main competitor, VX-REXX, in many ways. We hope Hockware will continue to add depth to this feature-rich product.

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also display skeleton code for the highlighted method in a fourth panel beneath the main code section on the left. You can highlight this template and drag it into the main code panel for use in your program.

Menus are also easy to construct. Double-clicking on the menu bar calls up a dialog box with a tree view of existing menus. Two CUA-compliant pull-down menus for File and Help are automatically provided for you, including all of the mnemonic shortcut keys and function calls. If you want to move an item to another location, you can drag and drop the item directly. Push buttons are provided for adding siblings and children and for deleting menu items. Creating a pop-up menu, which is just as simple, is accomplished by calling the menu builder from the object's style dialog. Unfortunately, you can't reuse action-bar menus as pop-ups, but for menus invoked exclusively as pop-ups, the approach is more logical than the methods employed by VX-REXX and VisPro/REXX. (In those packages, you can't create an independent pop-up menu. Instead, you must construct an action-bar menu, then hide it.) Of the three packages, Gpf Rexx's menu builder is the easiest to use.

Multimedia support is one of Gpf Rexx's strongest features. If you want to build sophisticated-looking multimedia applications, Gpf Rexx is your best choice. You can certainly call OS/2's multimedia extensions to REXX from any of the packages reviewed here, but only Gpf Rexx has special built-in functions for handling multimedia events, and its tool set of multimedia widgets far surpasses those of the other products. (VisPro/REXX includes a circular slider, and VX-REXX has no special controls.) Gpf Rexx has a circular slider and a polymorphic graphic button that can assume the appearance of 13 different types of VCR controls, such as load and unload media, mute, record, pause, and eject buttons, as well as an assortment of playback controls. The multimedia objects have a polished 3-D look, and several configuration options give you fine-tune control over their appearance and behavior. You can raise or recess text, specify how an object looks when pressed, and even animate the graphical image on the object.

Unfortunately, like so much else in Gpf Rexx, the multimedia features are poorly documented. A simple tutorial is provided in the user manual, but it doesn't illuminate any of Gpf Rexx's more powerful features. Special purpose functions—such as those for multimedia, SQL databases, and communications—aren't even mentioned outside of the Function Reference, and the Function Reference itself is merely a brief listing of each function's format, parameters, return values, and applicability, along with a one- or two-sentence description of what each does. Samples are occasionally provided, but you're pretty much on your own in figuring out how you might actually use these functions in an application.

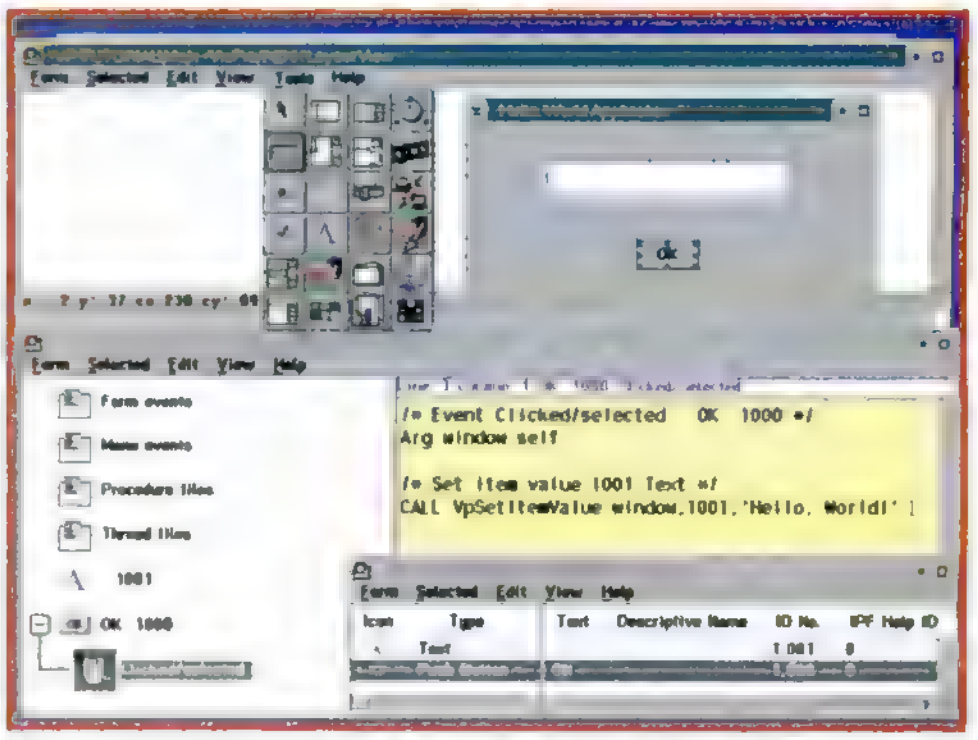
Apical Software is aware of these shortcomings and promises to improve its documentation in the future. In the meantime, unless you want low-level interface control, or you need its multimedia tools and don't mind figuring things out for yourself, this powerful and versatile package is probably not for you. **Gpf Rexx 2.1.** List price: $199. Apical Software Inc., Moodus, CT; 800-831-0017, 860-873-3300; fax, 860-873-3302. *Circle 467 on reader service card.*

Hockware Inc.

VisPro/REXX

VisPro/REXX has been engaged in a feature war with VX-REXX ever since the two products started shipping, and developers and power users alike have been the beneficiaries. Although VisPro/REXX lacks the elegance and polish of VX-REXX, the two products are quite similar in their Workplace-Shell look and feel. For the time being, VisPro/REXX has gained a slight lead in the feature war, since it currently ships with tools for data modeling and team programming. Neither of the other two products in this review offer anything in those arenas.

The VisPro/REXX Database Designer uses entity-relationship (ER) diagrams to represent databases graphically. ER diagrams are standard in the relational database community, so using this method of visualizing a database makes sense and minimizes the need for additional training. For those who aren't familiar with ER conventions, the documentation provides a good introduction. The documentation also does a nice job of explaining general relational database principles in layman's terms.



VisPro/REXX is the most feature-laden entry among OS/2 0 programming environments.

ER diagrams add a new dimension to visual programming, since so much information is conveyed in them. VisPro/ REXX lets you either generate a database from an ER diagram you've composed or reverse-engineer an ER diagram from an existing database. Generating a database from an ER diagram lets you visually establish referential integrity rules that are automatically included in the schema—much simpler than constructing SQL statements from a menu.

Like the VisPro/REXX screen painter, the Database Designer has a set of tools that you can load on the cursor and drop into your application by clicking anywhere on the canvas. There are tools for adding tables and relationships to the diagram, and you can use direct editing to supply table names, define relationships between tables, and arrange the objects on the canvas. Double-clicking on a table or a relationship brings up a Settings notebook with tabbed pages for Attributes (in the case of Table objects) or Foreign Keys (in the case of Relationships). To add columns to a table, you go to the Attributes page, enter the name of the column, and select options to define its characteristics. Data types are provided in a drop-down list box; the selection varies, depending on the data types supported by the DBMS associated with the diagram. (For example, a RAW data type is supported by Oracle but not by DB2/2.) Unfortunately, VisPro/REXX provides no help for DBMS-specific data types, though it does include a brief description of generic SQL data types.

VisPro/REXX can connect to any ODBC database or to databases with ODBC-compliant interfaces, such as IBM's Call Level Interface (CLI). (Both DB2/2 and Watcom SQL support the CLI interface.) VisPro/REXX can also connect to Oracle 7.1 via Oracle's REXX interface. The Oracle REXX interface, however, can't take advantage of the Database Designer's reverse-engineering option. To use that feature, you must have an ODBC-enabled driver.

The Database Designer's ER diagrams can be exported to text files as Data Definition Language (DDL) macros—REXX programs with embedded SQL—or as SQL statements alone. You can also export the diagram itself to an OS/2 metafile. The export feature is a great time-saver, but it takes a simplistic approach to modifying an existing database. Rather than checking the current database schema and issuing appropriate ALTER TABLE DDL statements, VisPro/REXX drops each table and defines it anew—not a good thing to do with a populated database. You'll need to edit the DDL statements manually to avoid disaster.

Once you have a diagram, VisPro/REXX can automatically generate a user interface for you, or you can use drag-and-drop programming to bind the ER diagram to the user interface and

specify the operations you want to perform. (As in VX-REXX, all interface controls can be made data-aware.) Drag-and-drop programming was one of VisPro/REXX's first salvos in the feature war with VX-REXX, which was quick to adopt it as well. Drag-and-drop programming lets you establish visual links between objects so that the system can help you determine which methods to use, then automatically insert appropriate code into your program.

For example, if you want to set the value of an entry field when a button is pressed, you call up a code window for the push button's "Clicked" event. Then, you click on the entry field and drag it to the point in the code window where you want to insert the new code. This establishes a link between the entry field and the push button. VisPro/REXX then pops up a list box of possible links, and you select "Set item value" from the list to automatically insert the code for this function. All you have to do now is type over the placeholder values in the function to complete the routine. This is a great feature for developers, because it minimizes typing errors and, consequently, debugging time. It's also a good way to encourage novices to use the product—so much code is generated automatically.

In the area of team development, VisPro/REXX provides a rudimentary change-log facility called the VisPro Team Administrator. When developers using this facility work on a component, VisPro/REXX logs the object name, the action (for example, ADD or DEL), the user, and the date and time. A team administrator can view the history, compare versions, and roll back any unwanted changes. It's a far cry from industrial-strength version control, but at least it's a step in the right direction.

What VisPro/REXX, a worthy competitor of VX-REXX, lacks in sophistication, it makes up for in ever-increasing breadth of features. **VisPro/REXX, Gold Edition 3.01.** List price: $299. Hockware Inc., Cary, NC; 919-380-0616; fax, 919-380-0757; http://www.hockware.com/hockware. *Circle 468 on reader service card.*

Powersoft Division, Sybase Inc.

Watcom VX-REXX

VX-REXX has matured considerably since we last reviewed it ("Cross-Application Macro Languages," February 8, 1994). Now, going beyond the simple, elegant development environment that impressed us enough to give it an Editors' Choice award, VX-REXX has refined many of its features and increased its muscle power to support client/server database development.

One of the things we liked about VX-REXX was its clean, modular design, and that hasn't changed. The VX-REXX architecture is quite flexible, accommodating a wide range of ap-

SUMMARY OF FEATURES *Continues*

OS/2 REXX Visual Tools

PC MAGAZINE EDITORS' CHOICE

■ YES ▣ NO

Products listed in alphabetical order	Gpf Rexx 2.1	VisPro/REXX, Gold Edition 3.01	Watcom VX-REXX 2.1D, Client/Server Edition
List price	$199	$299	$299
Interface Building			
Native GUI controls:			
CUA '89 controls: entry, MLE, static text, push button, radio button, check box, list, combo, scroll bar	■	■	■
CUA '91 controls: container, notebook, vertical slider, horizontal slider, value set, spin button	■	■	■
Multimedia controls:			
Circular slider	■	■	▣
VCR buttons	■	■	▣
Graphical objects:			
Lines	■	■	■
Polygons	■	■	■
Frames	■	■	■
Icons	■	■	■
Bitmaps	■	■	■
Pointers	■	■	■
Database controls	None	None	Connect, query
Other controls and objects	3-state button	3-state check box, full-motion video frame, free-form window, business graphic, DDE client	Timer, chart
Toolbars	■	■	■
Menus:			
Predefined CUA menus	■	■	■
Accelerator keys	■	■	■
Pop-up menus	■	■	■
Predefined dialogs:			
File Selection	▣	■	■
Font Selection	▣	■	■
Message, Prompt, and Error dialogs	■	■	■
Programmer can import custom controls	■	■	■
Programmer can create child windows	■	■	■
Programmer can utilize binary resources	■	■	■
CUA-compliance checking	■	■	■
Automatic field generation	■	■	■
Online help generation:			
General	■	■	■
Context-sensitive	■	■	■
Hints	■	■	■
Programmer can incorporate text files	▣	■	■
Programmer can incorporate .IPF files	■	■	■
Programmer can incorporate .INF files	▣	■	■
Database Support			
SQL back ends (native drivers)			
DB/2 2	■	■	■
Oracle 7.1	■[1]	■[1]	■[1]
Watcom SQL	▣	■	■
ODBC	▣	■	■
Other	IBM OS/2 Database Manager	None	Sybase SQL Anywhere
Queries database for table names	■	■	■
Constructs queries from menus	▣	■	■
User can view constructed SQL code	▣	■	■
Automatic binding to database fields	▣	■	■
Supports graphical joins	■	■	■
Can link to multiple sources	▣	■	■

(1) Via Oracle REXX support, not native drivers.

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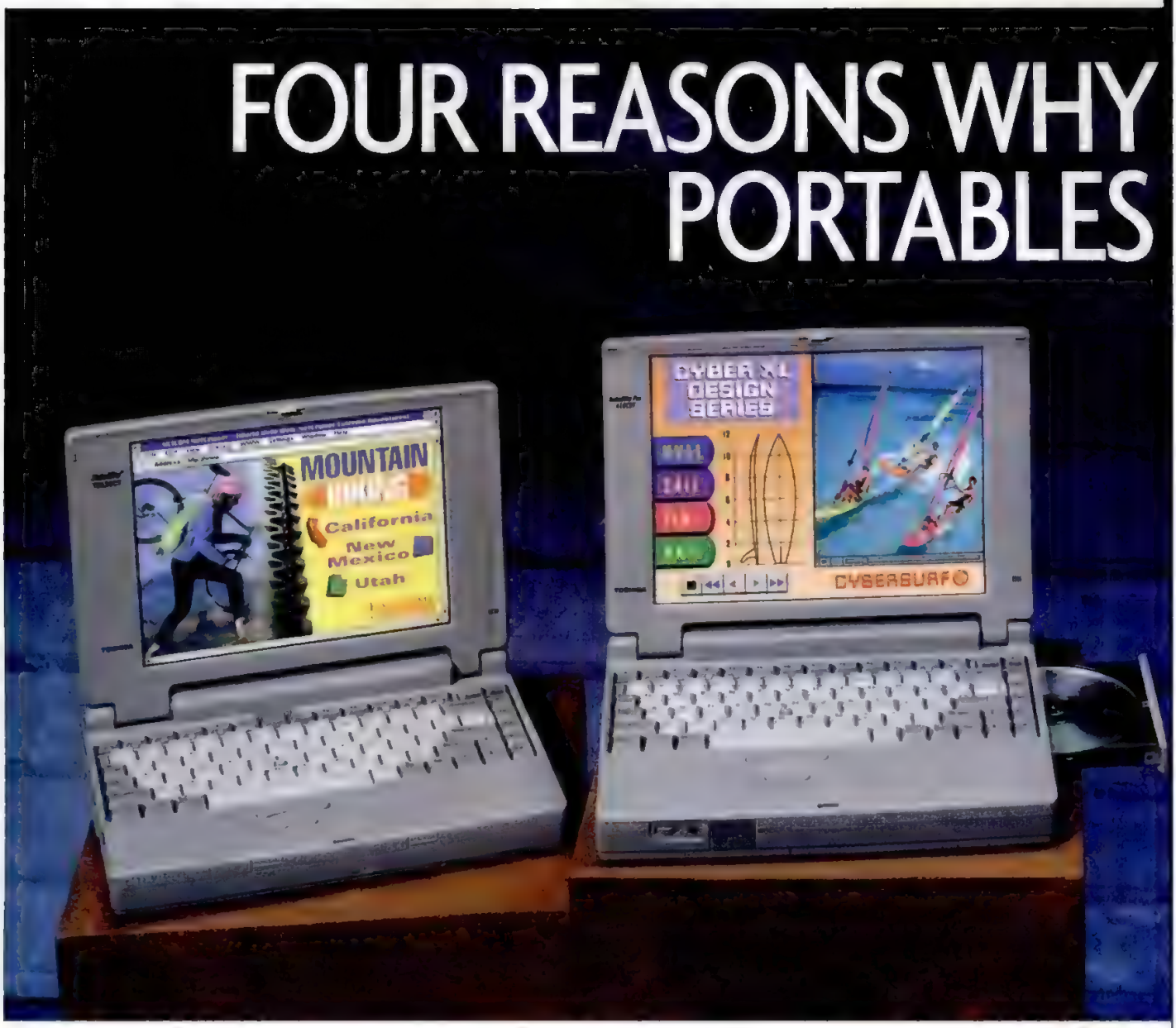

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plications. Applications are managed as projects and a project can simply be a headless, or nonwindowed, program with a single file of code, or it can comprise multiple windows and code files running on multiple threads. You can even share windows and code among projects across a network. The architecture you choose will depend on how much you want to reuse existing code and how much information you want to share among components. Of the three products reviewed here, VX-REXX gives developers the broadest range of possibilities for configuring applications.

To begin a new project in VX-REXX, you drag a project template to the workplace, thereby creating a folder containing a project file (.VRP), a source code file (.VRX), and a binary information file (.VRY) for the project. All of these files are associated through the Workplace Shell. Although it's possible to edit the source code file in a text editor, all of your work can be done through the project file. You can begin designing the GUI interface by double-clicking on the .VRP file, which will start the VX-REXX designer and load the project.

The VX-REXX development environment is well designed and efficient. The tool palette and various lists for the project—such as File List and Section List—are placed in separate windows from the screen painter, so you can move them anywhere on the screen.

Most GUI screen painters let you construct the user interface by selecting a control from the palette and placing it onto a window. The screen painters then let you directly manipulate the object to resize, reposition, or label it. Double-clicking on the object lets you set the object's properties. VX-REXX's screen painter does the same, but, in subtle ways, it makes the process more natural and intuitive than do other environments—either by minimizing keystrokes or by keeping the interface direct and uncluttered. For example, passing the mouse across the tool palette in VX-REXX flashes the name of each object on the status bar as the pointer passes over it. In VisPro/REXX, you must actually click on the object to see its name displayed, but since this action simultaneously loads the object on the cursor, you also have to click on the pointer tool to unload it if you don't intend to use it right away. By contrast, you expend much less effort in VX-REXX. This kind of simplicity is characteristic of the tool.

Another example of how VX-REXX makes a developer's life easier can be seen in its management of code. VX-REXX stores all of the REXX code associated with a primary window in a single text file, but uses labels and comments to segment the file into smaller sections. When you want to attach code to an object, the VX-REXX Section Editor will display only the segment of code associated with that particular object and event. This approach saves you from having to search through a large text file to locate the section you want, but still allows you to

SUMMARY OF FEATURES

OS/2 REXX Visual Tools

Ends

PC MAGAZINE EDITORS' CHOICE

■ YES ▨ NO

Products listed in alphabetical order	Gpf Rexx 2.1	VisPro/REXX, Gold Edition 3.01	Watcom VX-REXX 2.1D, Client/Server Edition
Database Support (continued)			
Other database tools	▨	Database Designer [2]	Database Administrator
Programming Features			
Can utilize external REXX modules	■	■	■
Supports multithreaded applications	■	■	■
User can edit generated code	▨	■	■
Provides ready-made forms or templates	▨	■	▨
IDE features			
GUI screen painter	■	■	■
Resource editor	▨	■	■
.IPF editor/builder	■	■	▨
Can integrate external code editor into IDE	▨	■	■
Multiple files supported	▨	■	■
Multiple screens supported	■	■	■
Drag-and-drop programming	▨	■	■
Automatic code generation	■	■	■
Other	None	Event Tree, Paint Utility	None
Help:			
System or API help	▨	■	■
Online documentation	■	▨	■
Interoperability with other programs:			
Executes OS/2 commands	■	■	■
Sends keystrokes to other programs	▨	▨	■
DDE client	■	■	■
DDE server	■	▨	▨
Creates REXX macros	▨	■	■
Other	None	Shared memory, clipboard functions	Drag-and-drop with WPS
Team programming:			
Change log	▨	■	▨
Multiple-programmer support	▨	■	▨
Developer security levels	▨	▨	▨
Interactive debugging:			
Breakpoints	■	■	■
Watchpoints	▨	■	▨
Watch variables	■	■	■
Step-trace execution	■	■	■
Can save restart options	■	▨	▨
Programmer can debug multiple threads	■	■	■
Programmer can test in development environment	■	■	■
Distribution and Technical Support			
Packaging:			
Creates standalone .EXE	■	■	■
Creates compiled runtime module (DLL or other)	■	■	■
Generates external source code	▨	▨	■
Encrypts object code	■	■	■
Includes Help compiler	■ (except for .IPF)	▨	■
Royalty-free distribution	■	■	■
Portable to other platforms and languages	■	■ (visual components but not code)	■
Free technical support	■	■	■ (for installation only)
Toll-free number	▨	▨	Optional (with annual support)

(2) Requires ODBC driver for Oracle.

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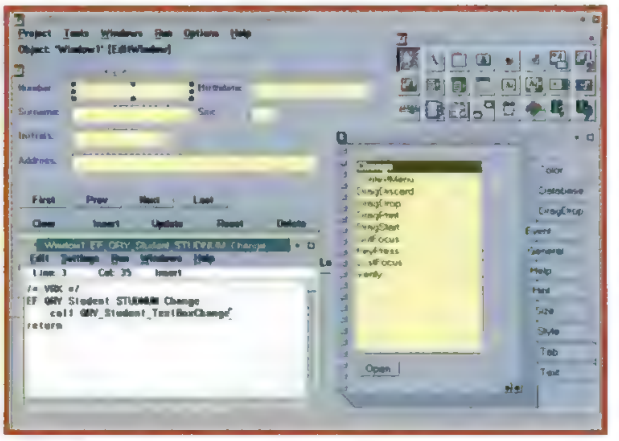
share variables among sections without passing parameters. (Variables are visible to the entire file. If you want variables to be local to the section, you can tag the section as a Procedure.) For multiple-file applications, VX-REXX provides an invisible Application object for passing variables among files and for managing threads.



VX-REXX uses a tabbed notebook metaphor to give you easy access to an object's properties.

Ease of maintenance is another plus of VX-REXX. For example, each object must have a unique name, or object identifier, so that you can reference it in your code. One of the maintenance challenges programmers face with object names is that, on having to change the name for some reason (the name clashes with legacy code you want to import, say), programmers usually have to search through the whole project manually and replace the old name with the new name. Not so in VX-REXX. Once you change the object identifier in the Properties notebook, VX-REXX automatically changes all references to it everywhere in the project. This feature can be a tremendous time-saver, and it demonstrates that the designers of VX-REXX understand production programming.

VX-REXX's debugger still doesn't support conditional breakpoints, and though it can trace through multiple threads, the process is not straightforward. VisPro/REXX, on the other hand, supports conditional breakpoints and does a much better job of handling multiple threads. Unfortunately, neither of these packages can save reset options. If you encounter an exception that shuts down the debugging session, you must start from scratch, reentering all of your breakpoints, watch variables and so on.

Once you've completed working on a project, you can generate a standalone EXE program, or you can build a DLL to run with the VX-REXX runtime module. VX-REXX can also produce REXX macro files for use in other programs. And its interoperability with other systems is enhanced by its ability to send keystrokes to other REXX-aware programs.

The Client/Server Edition of VX-REXX has a number of other tools for creating database front ends. It supports DB2/2, Sybase SQL Anywhere (and its predecessor, Watcom SQL), and any ODBC database. Aside from the standard interface widgets, which can all be made data-aware, the Client/Server Edition provides two database controls on the tool palette for managing connections and running SQL queries. The Connection object establishes a single connection to a database. The Query object represents a database query or cursor. You can include any number of Connection and Query objects in your application. This feature makes it possible to connect to more than one data source and to display the results of multiple queries in a single window—something the other packages in this review do not directly support (although you could conceivably write code to accomplish the same results).

Another database tool, the Database Administrator, allows you to define tables and views and to look at data. The Database Administrator uses a tabbed notebook metaphor, which is fine for defining tables and attributes, but which doesn't work well for looking at data. The entire result set is returned in a list box on a notebook page, and though you can resize the notebook, you can't adjust the list-box size. Unless your table consists of only one or two columns, you almost always have to do a lot of horizontal scrolling. The Query Editor, which also utilizes a notebook metaphor, has the same problem. Keep in mind, however, that these are just rare instances of VX-REXX tools not fitting VX-REXX's otherwise elegant image.

But if all else were equal, VX-REXX would still outshine the other visual REXX tools with its documentation and online Help system. Documentation is available online as well as in hard copy, and it is comprehensive, well presented, and well written. The context-sensitive online Help facility is *truly* context sensitive. Double-clicking on a highlighted item (for example, a function or keyword) while pressing Ctrl in the Section Editor will call up Help specific to that particular item. It is even hyperlinked to OS/2's REXX documentation, in ca se you forget some REXX basics.

VX-REXX is a high-caliber product that's a joy to work with and a good value for your money. □

Watcom VX-REXX 2.1D, Client/Server Edition. List price: $299. Powersoft Division, Sybase Inc., Waterloo, ON, Canada; 800-265-4555, 519-886-3700; fax, 519-747-4971; http://www.watcom.on.ca. *Circle 469 on reader service card*

Gabrielle Gagnon is a frequent contributor to PC Magazine.

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By Sheryl Canter

The Windows 95 Service Pack 1

What fixes and new features will it give you?

The quiet release of the Microsoft Windows 95 Service Pack 1 was a far cry from the original Windows 95 launch extravaganza, but its bug fixes, new components, new and updated device drivers, and updated tools for system administrators are well worth having. The new components include Microsoft Internet Explorer 2.0, Windows NT Server Management Tools for Windows 95, and an update to Microsoft Exchange that lets you access Microsoft Mail shared folders. Many of these fixes and tools have been available for downloading for some time, but Service Pack 1 brings them all together in one place.

If you are enrolled in Microsoft Select, Microsoft TechNet, or Microsoft Developer Network Level II, you will automatically receive Service Pack 1 with your next scheduled edition. You can also download it from the Internet (*http://www.microsoft.com/windows*), MSN (GO Windows), and CompuServe (GO WinNews). You can order CD-ROM or disk versions directly from Microsoft for $14.95.

To install the core portion of Service Pack 1—the essential bug fixes to the operating system itself—you simply run Setup, and your operating system is upgraded to Version 4.00.950a (Win95A). The only obvious change you'll see after running Setup is a new icon in your System Tools folder called Update Information Tool (see Figure 1). This handy applet tells you exactly which components have been updated in your system and in your registry and gives their version numbers. If you select the Updated Files Found page, the Update Information Tool scans your hard disk for upgraded components; it's a helpful diagnostic tool if something isn't operating correctly.

Running Setup does not install the new components, the administration tools, or the driver portion of the service pack; you must install each of these separately. Detailed instructions for doing so are included in README.TXT and documentation files.

THE CORE UPDATE

The core portion of Service Pack 1 consists of an OLE32 update, a shell update, a common dialog update for legacy printer drivers, a printer port update for bidirectional communications with certain printers, a password list update that improves security, a System Agent update, and various security fixes for specific types of networks.

The OLE32 update fixes a problem that could cause some embarrassment—or worse—when you share files created with the Windows 95 versions of Microsoft Word, Microsoft Excel, or Microsoft PowerPoint. Those applications all use OLE for file storage, and because of a bug in the original version of OLE32, information you thought you had deleted might still be visible when your file is viewed with another editor, such as Notepad. A similar problem exists under Windows 3.1 if you're using Word 6.0, Excel 5.0, or PowerPoint 4.0. The "C" releases of those products fix the problem.

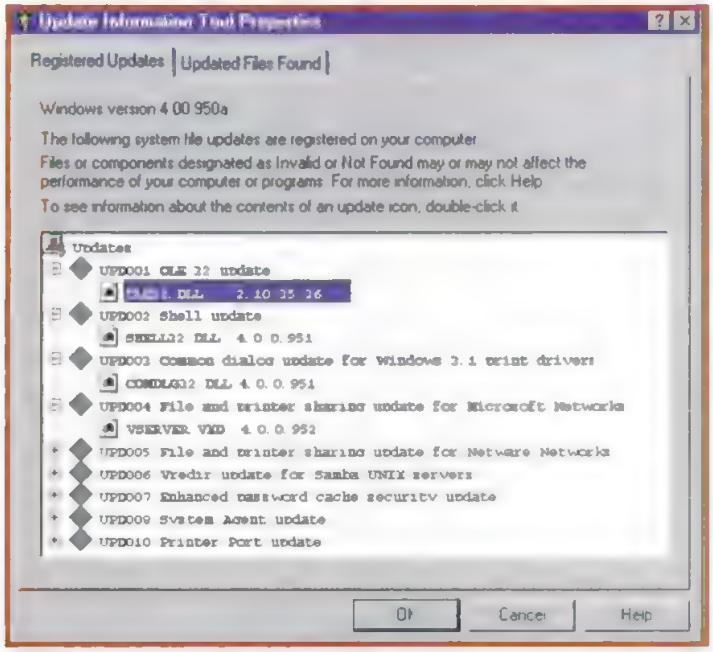

FIGURE 1: *The Update Information Tool lists the operating system updates registered on your system.*

The shell update, which replaces Shell32.dll, lets those using NetWare Directory Services (NDS) browse NDS printers from the Add Printer wizard, which is found in the Printers folder. It also corrects a problem that causes files copied onto themselves to be truncated to 0 bytes under certain conditions.

The common dialog update for Windows 3.1 legacy printers corrects a problem that occurs when you print from 32-bit applications using monolithic drivers or the pscript.drv/unidrv.dll driver. An update to Lpt.vxd adds support for the Extended Capabilities Port (ECP) bidirectional communications offered by HP LaserJet 4- and 5-series printers and some Lexmark LaserPrinters. The fix prevents timeout errors during printing. (Actually, the Lpt.vxd update was included on the original Windows 95 CD-ROM, but it wasn't installed during default setup.)

When you connect to a password-protected resource such as a network drive, you can choose to save your password so you're not prompted again in the future. Passwords are stored in an encypted file. The password list update corrects a weakness in the password file encryption scheme that was exposed when someone posted a decryption algorithm on the Internet. According to Microsoft, the update provides encryption that is harder to crack than the original method by a factor of 2^{96}.

The System Agent update, which is actually an update to the Plus! pack, replaces Sage.dll. When System Agent 1.0 is running, programs that perform floating-point calculations may be slightly off in precision. The update corrects this problem.

The network updates include a variety of fixes, mostly involving security, that affect users of specific networks. The Vserver update fixes a file- and printer-sharing security problem on Microsoft Networks that occurs with

smbclient, the network client component of the freeware Unix-based suite Samba. Windows 95 lets smbclient users gain unauthorized access to the drive on which sharing is enabled by accepting certain networking commands. This isn't as bad as it sounds. Users don't have automatic access to the drive and they must know exactly what steps to take, so the security hole isn't gaping. But this fix prevents Windows 95 from accepting these commands and thus prevents smbclient users from accessing the drive. Access is restricted, as it should be, to only those folders that the Windows 95 user has designated as shared.

The NWServer update corrects a file- and printer-sharing security problem on NetWare networks. The security hole occurs if your computer is configured for file and printer sharing and Remote Administration is enabled. After the administrator has logged off your computer and before you have restarted it, another user on the network can gain read-only access to your hard disk. The updated driver closes this security hole and lets only valid administrators access the drive.

The Vredir update fixes a file-naming problem that affects Windows 95 users who use the Samba Unix server. The problem occurs because although Windows 95 and Unix both allow the use of the backslash and asterisk in file specifications, those characters have different meanings for each operating system. In Unix they are legal filename characters, and in Windows 95 they have special functions. So if a Samba server contains a file named \server\share*.* and a Windows 95 user tries to delete the file *.* from Explorer, all the files in the directory \server\share will be deleted. The Vredir update solves this problem by disallowing server filenames that contain the \ or * characters.

NEW COMPONENTS

The new components of Service Pack 1, which can be found in the \ADMIN\COMPONTS folder on the CD-ROM version, include Microsoft Internet Explorer 2.0, scripting and SLIP (Serial Line Internet Protocol) support for the Dial-Up Networking tool, Microsoft Word Viewer 7.1, an infrared driver, a 32-bit DLC (Data Link Control) protocol, service for NDS, an update to Microsoft Exchange, and Service Pack 1 setup programs for use by network administrators.

Internet Explorer 2.0 offers a number of new features, including support for HTML tables. It also adds a basic newsgroup reader. (There was no newsgroup support at all in Version 1.0.) New multimedia features include support for background sounds, scrolling marquees, and inline video. Its performance has been improved by several methods. For example, text is now displayed immediately, with placeholders for graphics, so you don't have to wait for the program to download them before you can click on a link. Security has been enhanced, as well, with support for Netscape's Secure Sockets Layer (SSL) encryption.

The Microsoft Word Viewer 7.1 lets you view and print files created with Microsoft Word for Windows without having Word on your hard disk. Although you cannot edit the files, you can copy information from them to the clipboard, and you can activate OLE objects embedded within them. If you have Word 6.0 or later on your hard disk, the installation program will ask you whether you want to launch Word Viewer or Word when you double-click on .DOC files.

The new Infrared Driver lets you use IrDA devices for wireless connections to peripherals or other Windows 95 computers. The new 32-bit DLC protocol, which supports both 32-bit and 16-bit DLC programs, lets you access IBM mainframe and IBM AS/400 computers. With Service Pack 1, Windows 95 provides full client support for NDS through Service for NDS and Client for NetWare networks.

In addition to these new components, there are updates to four components in the \ADMIN\COMPONTS\UPDATES folder: Microsoft Exchange, Netsetup, Prompted Update, and Silent Update. The update to Microsoft Exchange lets users access Microsoft Mail shared folders. (The Microsoft Mail information service included with Windows 95 does not provide access to shared folders.) After you install this upgrade, you must reconfigure Exchange to take advantage of the new feature.

Netsetup, a tool for network administrators whose users are running Windows 95 from the server, updates the distribution point on the server with the Service Pack 1 files. The two versions of the Setup program, Prompted Update and Silent Update, are for networks where users are running Windows 95 from their hard disks. The Prompted Update program asks users whether they'd like to install the update and reminds them to restart their systems after the updates have been completed. The Silent Update doesn't prompt users to confirm the updates or to restart their systems; it simply copies the files. The tools for setting up these options are stored in \ADMIN\TOOLS\SMS on the CD-ROM.

NETWORK MANAGEMENT TOOLS

The administration tools, found in \ADMIN\TOOLS on the CD-ROM version, help network administrators upgrade users on their networks to Win95A. They include Windows 95 Support Assistant, Batch Setup 2.0, INF Generator Tool, INF Installer Tool, and Windows NT Server Management Tools for Windows 95.

The Support Assistant is a Help file that contains information relevant to installing Service Pack 1 on a network. Included are a FAQ (Frequently Asked Questions) file, the Windows 95 Resource Kit section on networks, some Knowledge Base articles on networking, procedures for troubleshooting, application and hardware compatibility lists, a guide to products and services, and a glossary of Windows 95 terms.

The Batch Setup utility helps administrators update many computers on a network at once. Version 2.0 adds a variety of new features. You can have Batch Setup scan your Windows 95 Registry and create an .INF file based on your current settings. Also within Batch Setup you can specify which protocol to make the default, enable or disable all optional components with a single mouse click, configure file and print services for Microsoft and NetWare networks, enable or disable the Netcard Resource Conflict Resolution Wizard during setup, find user-level security settings, and locate client TCP/IP settings, such as DNS servers.

The updated INF Generator Tool lets you choose separate settings for companies, departments, and individual users. This feature is especially useful when using static TCP/IP settings rather than the Dynamic Host Configuration Protocol (DHCP). The INF Installer Tool lets you integrate .INF and related files from the various \ADMIN\TOOLS directories for easier installation.

The Windows NT Server Management Tools for Windows 95 provide basic server tools (Server Manager, User Manager, and Event Viewer) that let you manage Windows NT servers from Windows 95 client machines.

EVEN MORE DRIVERS

The last big category in Service Pack 1 is third-party device drivers. New or updated drivers are supplied for sound cards, display adapters, modems, network cards, printers, SCSI controllers, PCI buses, Mouse System mice, and various UPSs. New drivers are developed all the time. The drivers on the CD-ROM and disk versions of Service Pack 1 are a snapshot of what was available when the CDs or disks were created. To be sure you have the most recent drivers, you should check one of Microsoft's online sites.

Anyone running Windows 95 should take the time to install Service Pack 1, if only for the plugs to security gaps. Although you won't need every fix and feature, you're bound to find at least one or two that affect you, and you can obtain Service Pack 1 at little or no cost. □

Microsoft Windows 95 Service Pack 1. List price: $14.95 in CD-ROM format, downloadable for free. Microsoft Corp., Redmond, WA; 800-426-9400; in Canada, 800-563-9048; http://www.microsoft.com/windows. *Circle 441 on reader service card.*

Sheryl Canter is a contributing editor of PC Magazine.

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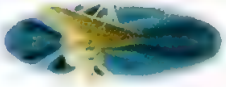

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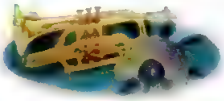

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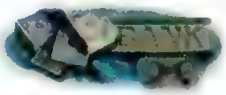
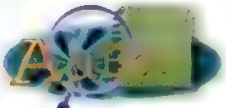
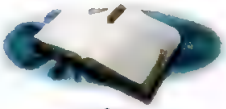


Document Readers

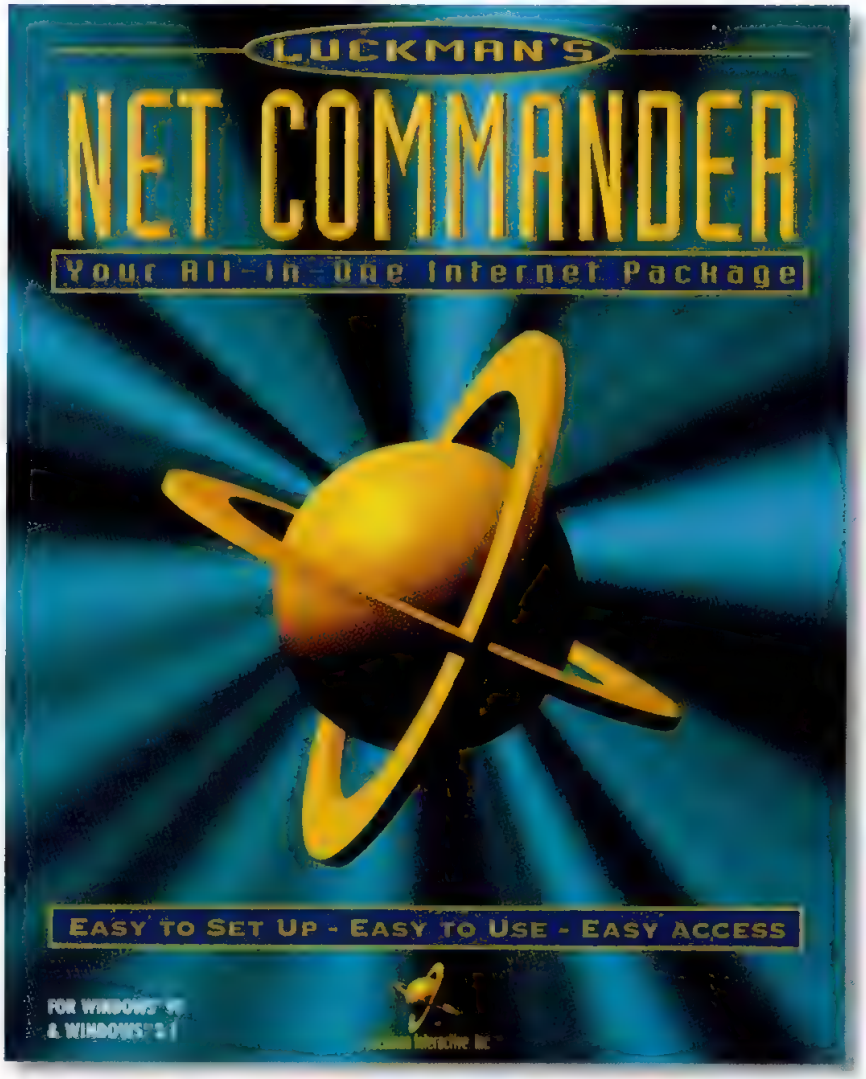


References



Utilities

Auto Account Registration



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CIRCLE 096 ON READER SERVICE CARD.

By Jeff Prosise

Crawling the Web

A guide to robots, spiders, and other shadowy denizens of the Web.

If you maintain a site on the World Wide Web, have you ever been "hit" repeatedly by a user who downloads tens, perhaps hundreds, of documents in rapid-fire succession? If so, your site may have been visited by a program that savvy surfers refer to as a robot, a spider, a wanderer, a Web walker, or a Web agent.

Robots are automated programs, and *spiders* are a type of robot that continually crawls the Web, jumping from one page to another in order to gather statistics about the Web itself or build centralized databases indexing the Web's content. Alta Vista, Lycos, OpenText, WebCrawler, and other popular Internet search sites use spiders to build Web indexes. These let users easily locate every Web page containing information about, say, the MD5 Message Digest Algorithm or tourism in the Canary Islands. (For more information about Internet search sites, see the Tutor column of June 11, 1996.)

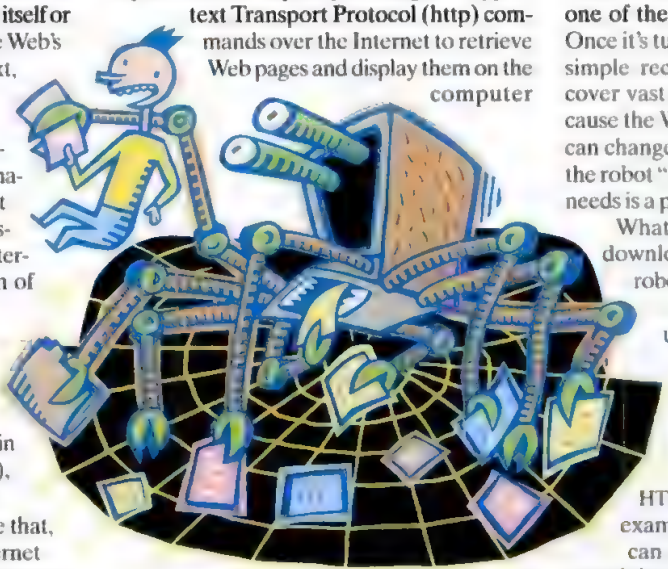
Spiders run unattended, so a single robot can do in a few minutes what it may take a human several hours to do. According to Digital Equipment Corp., whose Webmasters maintain Alta Vista (*http://altavista.digital.com*), its Scooter indexes about 2.5 million Web pages per day. With numbers like that, and considering the popularity of Internet search sites, it's easy to understand the appeal of robots.

Spiders provide a valuable service to Internet users; without them, it would be virtually impossible to build functional Web indexes and keep them up to date. But spiders have their downsides, too. They increase traffic over the Net, and a poorly written spider can hit a site so hard—and so frequently—that it impedes ordinary access. In addition, indexing robots have no way of discerning between permanent and temporary Web pages—unless the sites they visit have been made robot-aware. This contributes to clutter in Web indexes and makes the information you're really after just that much harder to find.

In short, robots are both a blessing and a curse. But they're a fact of life on the Internet, and they're increasing in number every day. Let's look behind the scenes to see what they do, how they work, and, more important, what site managers can do to make their sites more "robot friendly." We'll also discuss places you can go to obtain information about writing well-behaved robots.

HOW ROBOTS WORK

To understand how a Web robot works, it first helps to understand how a browser works. In essence, a browser is simply a program that responds to user input by sending out HyperText Transport Protocol (http) commands over the Internet to retrieve Web pages and display them on the computer screen. Web pages are actually HyperText Markup Language (HTML) files containing text, formatting codes, and other information defining content. "Other information" typically includes the addresses of files containing bitmapped images and hypertext links to other HTML pages.



Clicking a hypertext link to a remote Web page initiates a series of actions. First, the browser retrieves the Uniform Resource Locator (URL) address for the destination from the current page. Then it establishes a connection to the remote server, issues an http GET command to retrieve an HTML document, and displays the document on the screen. Normally, the text of the document is displayed first. Images are stored under separate URLs so they can be downloaded separately. Links to those images are stored in the document's text so that the browser knows where to find them and where they go.

A Web robot is a browser with an autopilot. Instead of the user clicking a hypertext link, the robot downloads a page from the Web and scans it for links to other sites. Then it picks a URL and jumps. From there it jumps to another Web site and begins the process again. When it encounters a site that doesn't contain links, it backs up a level or two and jumps to one of the links it skipped the time before. Once it's turned loose, a robot that employs a simple recursive navigation algorithm can cover vast distances in cyberspace, and, because the Web changes daily, the robot's path can change daily, too. In a conceptual sense, the robot "crawls" the Web like a spider. All it needs is a place to start.

What does a robot do with the pages it downloads? That depends on why the robot was created in the first place. Robots that index the Web typically use proprietary algorithms to generate document abstracts that go into a huge database of Web sites and their contents. They also build indexes correlating words and phrases found in HTML documents to URLs, so that, for example, someone using a search site can quickly get a list of all Web pages containing the word "Cozumel." One reason indexing robots can visit so many sites so fast is that they only have to grab HTML files. They don't have to download images, because the search databases can only index text.

Not all robots were built to index Web pages. Some exist just to identify links to pages that no longer exist. Others walk the Web to gather statistics regarding Web usage—for example, to determine which sites are the most popular by counting the number of references to them in other Web pages or to tally the number of Web pages as a tool for measuring growth.

It's not difficult to imagine why robots can place a strain on a server's resources. When a robot visits a site, it can request a large number of documents in a short period of time: It's as if a hundred or more extra users logged in all at once. Some servers will handle it; others

ILLUSTRATION BY ROBERT ZIMMERMAN

won't. That's one reason a set of informal protocols has emerged to describe "good" robot behavior. A well-behaved robot, for example, will space requests to a given server at least a minute apart so the server doesn't become overwhelmed. It will also identify itself so its owner can be contacted if problems arise, and perform internal checks on the URLs it visits to avoid redundant accesses.

THE STANDARD FOR ROBOT EXCLUSION

In 1994, while the Web was still in its infancy, a group of Internet users who recognized the problems that unruly robots could cause got together by e-mail and developed an unofficial standard known as the Standard for Robot Exclusion (SRE). The SRE defines a protocol that permits site managers to exclude robots from designated areas of their Web sites.

One very pragmatic use for the SRE is to prevent robots that are run by search sites from indexing temporary HTML documents that probably won't be around this time tomorrow. Many Web sites (search sites especially) generate HTML documents on the fly to fulfill requests from users. They then go back and delete those documents when they're no longer needed. Obviously, it does no one any good to have pages like these included in Web indexes. Another use for the SRE is to allow robots to steer clear of pages that are under construction or to leave instructions for them to avoid your site altogether.

Using the SRE to exclude robots from all or part of a Web site is simplicity itself. All you do is create an HTTP-accessible file on the Web server and assign it the local URL /robots.txt. This is a text file containing English-language commands spelling out access policies for robots. SRE-compliant robots look for this file when they first connect to a server and abide by the access policies contained therein. If there is no robots.txt file, the robot can assume that it's welcome anywhere in your Web site. Note that the onus is on you, the site manager, to tell robots where they can and cannot go. Also be aware that not all robots are SRE-compliant, and adherence to the commands in robots.txt is strictly voluntary on the part of the robot. Fortunately, the vast majority of existing robots either support SRE or are in the process of having SRE support added.

What does a robots.txt file look like? Here's a simple one that asks all robots to stay away from /tmp/documents and its subdirectories:

```
# Sample robots.txt file
User-agent: *
Disallow: /tmp/documents/
```

The first line is a comment line. You can place comments anywhere in a robots.txt file provided they're preceded with pound symbols. The second line designates the robots to which the access policies apply; "*" means all robots. The third line disallows access to the specified directory and to any directories below it in the hierarchy. You can include multiple Disallow statements to prohibit access to two or more directories.

In some cases, it might be desirable to allow certain robots access to areas that are off limits to other robots. The following robots.txt file allows unrestricted site access to a robot named Hal-9000 but prohibits others from accessing either /tmp/documents or /under_construction:

```
# Sample robots.txt file
User-agent: *
Disallow: /tmp/documents/
Disallow: /under_construction/
User-agent: Hal-9000
Disallow:
```

To tell SRE-compliant robots to skip your site altogether, simply create a robots.txt file containing these two statements:

```
User-agent: *
Disallow: /
```

Upon seeing this, well-behaved robots immediately disconnect and go find another server.

HELP FOR ROBOT AUTHORS

If your heart's desire is to create a Web robot of your own, you should first read a pair of Web documents called "Guidelines for Robot Writers" and "Ethical Web Agents." (For URLs, see the sidebar "Learning More About Web Robots.") These documents offer advice for writing friendly robots that don't tie up system resources and that identify themselves so their authors can be contacted if the robots misbehave. And be sure to make your robot SRE-compliant so it will be respectful of the sites it visits.

I've yet to find the source code for a real robot, but I'm sure that it's out there somewhere. There are several books that describe how to write programs that retrieve HTML documents from the Web. These make good starting points for learning to write robots of your own. One such book is *Internet Programming* by Kris Jamsa and Ken Cope (1995, Jamsa Press). It's a decent all-around book for getting started programming the Internet, especially if you're doing your programming in Windows.

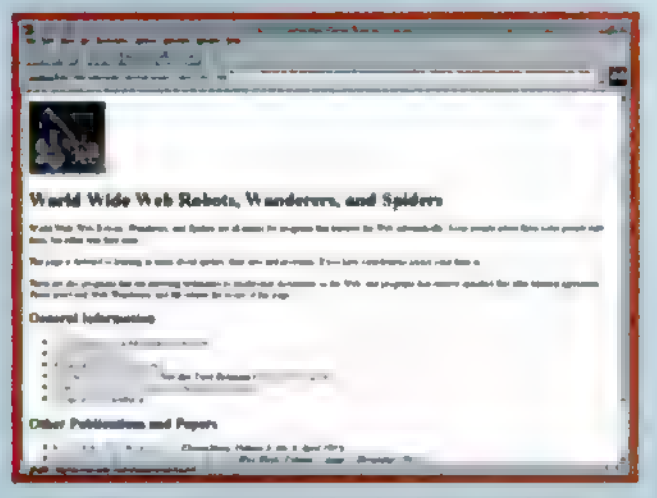
LOOKING AHEAD

In the future, look for the number of robots traveling the Web to increase. If you're a robot writer, abide by recognized standards and conventions for writing courteous robots. Space out your robot's requests for HTML documents so that one site doesn't get hit with dozens of requests at once and don't run robots unnecessarily. If you're a Web manager, consider adding a robots.txt file to your site so visiting robots will know which areas to go to and which to stay away from. □

Jeff Prosise is a contributing editor of PC Magazine.

Learning More About Web Robots

If you'd like to learn more about Web robots and stay apprised of the latest developments in this fascinating field, point your browser to the World Wide Web Robots, Wanderers, and Spiders page at *http://info.webcrawler.com/mak/projects/robots/robots.html*. On this page, you'll find an up-to-date list of resources containing information about robots and other Web crawlers. You'll also be able to link to other pages full of useful and interesting information:



This Web page provides links to information on Internet robots.

- A robot FAQ: *http://info.webcrawler.com/mak/projects/robots/faq.html*
- A list of known robots: *http://info.webcrawler.com/mak/projects/robots/active.html*
- A copy of the Standard for Robot Exclusion: *http://info.webcrawler.com/mak/projects/robots/norobots.html*
- Guidelines for writing well-behaved robots: *http://info.webcrawler.com/mak/projects/robots/guidelines.html* and *http://www.ncsa.uiuc.edu/SDG/IT94/Proceedings/Agents/eichmann.ethical/eichmann.xxx*
- And for suggestions on what to do when your site is overwhelmed by a robot: *http://info.webcrawler.com/mak/projects/robots/against.html*

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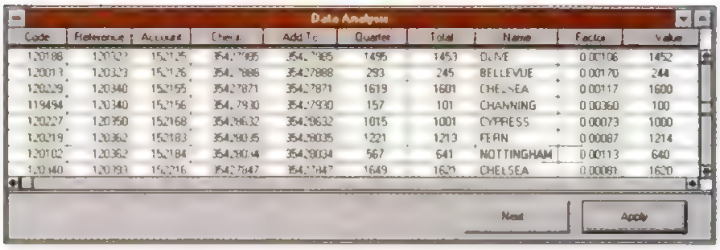

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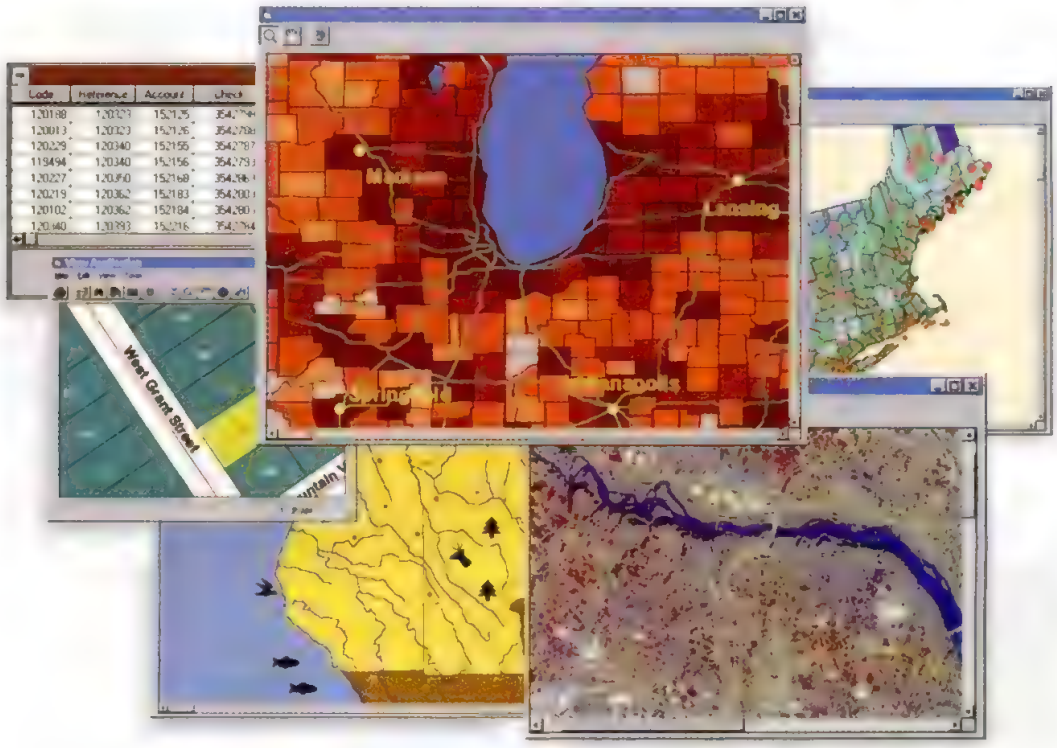

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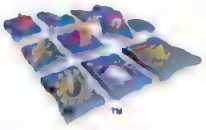

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CIRCLE 240 ON READER SERVICE CARD

By Paul Modzelewski and Gyorgy Grell

Using the DirectDraw API with C++

A primer on Windows 95's new game programming interface.

DirectDraw, the graphics component of Microsoft's new Game SDK, is a powerful new tool that finally gives developers low-level access to the millions of accelerated video cards in today's PCs. In this first of two installments, we will discuss exactly what DirectDraw is, as well as how you might use it. In the next article, we will introduce a game we have written using DirectDraw, along with the reusable C++ classes our game uses.

The DirectDraw API allows "direct" access both to video memory and to the graphics acceleration hardware built into most video cards sold in the last few years. DirectDraw supports a vast array of functionality, but many of its features are not yet supported by existing video cards or drivers.

Currently, DirectDraw has three main benefits. The first is *hardware blitting*, which is the ability to use the blitter on the video card to copy images from one area of video memory to another. In addition to standard blits (or *bit block transfers*), DirectDraw supports *transparent blits*, which ignore all pixels of a designated color, so they don't show up in the destination. Since hardware blits are performed asynchronously, the CPU is free to handle other chores.

The second benefit is *page flipping*, which involves creating two or more "screens": a front page and one or more back pages. The front page is the one currently displayed, and the back page is hidden from sight. All rendering is done on the back page, and when the image is complete, the pages are flipped: The newly drawn back page, now visible, becomes the front page. Conversely, the former front page is now the back page, and the next screen can be rendered on it.

The final advantage of DirectDraw is *color filling*. Color fills are like hardware blitting, but in this case the hardware fills a specified area of video memory with a single color. This can be handy for erasing sprites or entire pages.

THE DIRECTDRAW API

Function	Purpose
DirectDrawCreate	Creates an instance of a DirectDraw object.
IDirectDraw::SetCooperativeLevel	Determines the level at which the DirectDraw application cooperates with the GDI. Defines use of the entire screen (Exclusive mode) or only part of it.
SetDisplayMode	Sets the screen resolution and color depth. Works only with Exclusive-mode access.
IDirectDraw::CreateSurface	Creates a DirectDrawSurface and associates it with a DirectDraw object.
IDirectDraw::CreatePalette	Creates a DirectDrawPalette and associates it with a DirectDraw object.
IDirectDrawSurface::SetPalette	Attaches a DirectDrawPalette to a DirectDrawSurface. The surface will use the palette for all operations. The change to the surface is immediate.
IDirectDrawSurface::BltFast	Performs a source-copy blit or transparent blit using a source or destination color key. Works only on video memory surfaces and cannot clip. The software implementation of BltFast is 10 percent faster than Blt. There is no speed difference if the video hardware is being used.
IDirectDrawSurface::SetColorKey	Sets the color key of a surface if the hardware supports it.
IDirectDrawSurface::Blt	Performs a bit-block transfer. Capable of synchronous or asynchronous blits: video memory to video memory, video memory to system memory, system memory to video memory, or system memory to system memory.
IDirectDrawSurface::Lock	Obtains a valid pointer to the surface memory.
IDirectDrawSurface::Unlock	Notifies DirectDraw that the direct surface manipulations are complete.
IDirectDrawSurface::Flip	Makes the surface associated with the DDSCAPS_BACKBUFFER surface become associated with the front-buffer surface. The video memory previously associated with the front buffer is associated with the back buffer.

THE COMPONENT OBJECT MODEL

Before you use DirectDraw, a basic understanding of the Component Object Model (COM) specification is helpful, since all of the Game SDK's components are encapsulated in COM objects. A COM object is a lot like a C++ object, with some important distinctions. You can create an instance of a COM object, call methods of its *interfaces* (the equivalent of member functions), and destroy it when you're done using it. You cannot directly access COM objects' data members, and they do not have constructors or destructors. Usually a creation function is supplied instead of a constructor, and you use the Release method of the fundamental IUnknown interface instead of deleting a COM object.

Once you have a pointer to a COM object, you can call its member functions just as you would with a C++ object, since the COM format is recognized by most Windows C++ compilers. In fact, since the COM interface is effectively hidden by the DirectDraw API functions, we are free to refer to DirectDraw objects as if they were ordinary C++ objects.

You can use COM objects in straight C programs, but it's a little more cumbersome. For instance, in C, you would call a COM object's member function like this:

```
pDDSurface->lpVtable->Flip
 ( pDDSurface, NULL, NULL );
```

In C++, such a call would look like this:

```
pDDSurface->Flip(NULL, NULL);
```

The header files of the Game SDK contain some macros that make access from C less awkward.

SETTING UP DIRECTDRAW

The first step is the creation of a DirectDraw object with the DirectDrawCreate function. The DirectDraw object creates and owns all other objects in the DirectDraw API and is also the means by which you access all global functions, such as setting the display resolution or color depth.

```
hResult = DirectDrawCreate(NULL,
 &pDirectDraw, NULL);
```

The first parameter is a pointer to a GUID, which represents the driver for which the DirectDraw object should be created. Use NULL if you want the active display device, or you can use DDCREATE_EMULATIONONLY if you want to force the use of software emulation. (You might want to use emulation for debugging or testing purposes, or to make sure your application works in emulation mode. DirectDraw has a hardware emulation layer that emulates some of what might be missing from an actual DirectDraw video driver as well as capabilities not available on a video card, such as the ability to stretch an image.) If DirectDrawCreate succeeds, pDirectDraw will be initialized with a valid pointer to a DirectDraw object, and hResult will be DD_OK. If it fails, hResult returned will be a value other than DD_OK. The last parameter is for OLE2 aggregation features and can be left as NULL.

Once you have a pointer to a DirectDraw object, you need to set the cooperative level and display mode. Calling SetCooperativeLevel tells DirectDraw how friendly you want your application to be to other applications. Most applications using DirectDraw will want exclusive, full-screen access.

```
hResult = pDirectDraw
 ->SetCooperativeLevel(m_hWnd,
 DDSCL_EXCLUSIVE | DDSCL_FULLSCREEN);
```

When you've changed the cooperative level, you then set the display mode. DirectDraw has support for many display resolutions and color depths, but right now the only options that use hardware acceleration are 640-by-480 or 640-by-400 at 8 or 16 bits per pixel. The current release of DirectDraw also supports the ModeX resolutions of 320-by-200 and 320-by-240 at 8 bpp, but these modes constitute simple frame-buffer access, similar to DOS's. Using ModeX works only if your call to SetCooperativeLevel includes the DDSCL_ALLOWMODEX flag.

```
hResult = pDirectDraw
 ->SetDisplayMode(640, 480, 8);
```

You can return the display mode to its original state by calling RestoreDisplayMode, or it will be restored automatically when the DirectDraw object is released.

The next step is to create a primary DirectDrawSurface object, which represents either a display surface or an off-screen buffer and resides in either system or video memory. Its member functions allow the copying of data from one surface to another, page flipping, and much more. DirectDraw surfaces are created with the DirectDraw object's member function CreateSurface:

```
DDSURFACEDESC ddSurfaceDesc;
HRESULT hResult;
surfaceDesc.dwSize =
 sizeof(DDSURFACEDESC);
surfaceDesc.dwFlags = DDSD_CAPS |
 DDSD_BACKBUFFERCOUNT;
surfaceDesc.ddsCaps.dwCaps =
 DDSCAPS_PRIMARYSURFACE |
 DDSCAPS_COMPLEX | DDSCAPS_FLIP;
surfaceDesc.dwBackBufferCount = 1;
hResult = pDirectDraw->CreateSurface
 (&surfaceDesc, &pDDSurface, NULL);
```

This code snippet creates a complex, primary surface with a front buffer, one back buffer, and flipping capabilities. A complex surface is really just a way to create more than one surface with a call to CreateSurface. The DDSCAPS_PRIMARYSURFACE flag does two things: It makes the newly created surface the displayed surface and tells DirectDraw to size the surface to the current display mode.

You can create several other types of surfaces. Other than the complex flipping surface, the most common type is a plain off-screen buffer, which can be in either system or video memory; but remember, you can use hardware acceleration only on surfaces created in video memory. Since video RAM (VRAM) is a scarce resource, you should think of your VRAM as a cache and store in it only images that will be drawn frequently. Images not stored in video memory can be stored in DirectDraw surfaces created in system memory, but you may want to store them in your own format, since DirectDraw surfaces cannot be compressed yet.

The next step is to create a DirectDrawPalette object, using the CreatePalette function. DirectDrawPalettes represent 16- or 256-index palettes that can be attached to surfaces. Typically, you would create a 256-color palette. In order to do this, you need to create an array of PALETTEENTRY structures. These are the same RGB structures you would use to create normal GDI palettes. Once you have filled the array with the 256 color triples, you pass them to the CreatePalette function:

```
PALETTEENTRY pe[256];
hResult = pDirectDraw
 ->CreatePalette(DDPCAPS_8BIT, pe,
 &pDDPalette, NULL);
```

Once you have a palette, you will want to associate it with your primary surface:

```
ddrval = pDDSSurface
 ->SetPalette(pDDPalette);
```

Now all 8-bit values in the primary surfaces will be indexed into pDDPalette for the correct RGB values.

PUTTING DIRECTDRAW TO USE

Now that we've set up all the essential components of a DirectDraw application, let's discuss some of the functions and techniques likely to be needed in common-use scenarios.

Copying (or blitting) data from one surface to another is probably DirectDraw's most frequently used feature, so we'll take a closer look at how that works. Blitting from one surface to another is accomplished with the DirectDrawSurface member functions Blt and BltFast. These functions blit between any two system or VRAM surfaces, but remember, hardware acceleration is possible only when both source and destination surfaces are in VRAM.

For simple transparent and copy blits, the BltFast function is preferable to Blt. If you are using software emulation, BltFast is 10 percent faster than Blt; if you have hardware blitting, however, there is no speed difference. If you want to do a color fill or use some of the more esoteric blitting effects, you have to use the standard Blt function.

```
ddrval = pDestSurface->BltFast(nDestX,
 nDestY,
 pSourceSurface,
 &sourceRect,
 DDBLTFAST_SRCCOLORKEY);
```

This line copies the area defined by sourceRect from pSourceSurface to the nDestX, nDestY position in pDestSurface, using the source surface's color key for transparency. You can define a color key for any surface with the member function SetColorKey:

```
DDCOLORKEY ddck;
ddck.dwColorSpaceLowValue = 0;
ddck.dwColorSpaceHighValue = 0;
pSourceSurface
 ->SetColorKey(DDCKEY_SRCBLT,
 &ddck);
```

After this code has been executed, any time you blit from pSourceSurface to another surface and tell Blt or BltFast to use a source color key, all pixels with a value of 0 will be transparent.

Another useful type of blit is a color fill, which is accomplished with a call to the Blt function after you set the appropriate flags. The following code will fill the specified area of the destination surface with color 0.

```
DDBLTFX bltFX;
DWORD dwFlags = DDBLT_COLORFILL;
bltFX.dwSize = sizeof(DDBLTFX);
bltFX.dwFillColor = 0;
// set up fillRect
hResult = pSurface->Blt(&fillRect,
 NULL, NULL, dwFlags, &bltFX);
```

With games, you often don't want just to blit an image from one surface to another; you also want to manipulate the actual bits that

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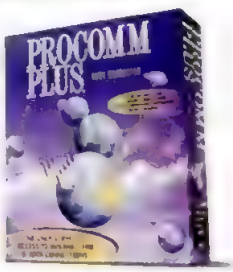

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represent the image in video memory. To do this, you need to get a pointer to the surface's memory with the surface's Lock function, which you must call with a RECT structure that contains the rectangle of the area to be locked. If you need the entire surface, the rectangle pointer should be NULL. When Lock is finished, the DDSURFACEDESC structure will contain a pointer to the surface memory in the lpSurface member. Remember to assign this to a pointer type, since it is LPVOID and has no size. Also note the DDLOCK_WAIT flag: DirectDraw could still be busy with blitting when you call Lock, which would then fail. With the wait flag, DirectDraw will wait for all blits to finish.

```
HResult hResult;
DDSURFACEDESC surfaceDesc;
hResult = pDDSurface->Lock(pDestRect,
 &surfaceDesc, DDLOCK_SURFACEMEMORYPTR
 | DDLOCK_WAIT);
BYTE* pBits = surfaceDesc.lpSurface
 // do your custom rendering here
 hResult = pDDSurface->Unlock(pBits);
```

After the Lock call, pBits will point to the target surface's actual memory, be it system or VRAM. When you are done writing to the surface, be sure to call the Unlock function. You have to be careful between Lock and Unlock calls because standard GUI debuggers cannot be used during this period.

In addition to locking a surface to do custom blitting, you can also obtain a standard Windows device context (DC) that refers to the given surface. The most useful advantage of doing this is to let GDI's TextOut function handle all of your text. Almost all modern video cards have some sort of hardware that quickly renders TrueType fonts, so this method is probably faster than the standard technique of storing a bitmap for each number or letter.

To get a DC for a surface, you call the DirectDrawSurface member function GetDC. The returned handle to a DC is a standard Windows hDC and can be used accordingly. When you are done with the hDC, you have to call ReleaseDC. Whenever a call to GetDC is made, DirectDraw makes an internal call to Lock, so the debugging restrictions between Lock and Unlock also apply between GetDC and ReleaseDC.

Whenever you are using DirectDraw, you have to be prepared to lose your surfaces. Losing a surface means that although the COM object is still in existence, the video memory that the surface used to own has been released. Surfaces can be lost for a variety of reasons, the most common being changes in the display mode, either screen resolution or color depth. That happens when the user switches to another application, since DirectDraw switches back to the original display mode when your application loses the focus.

When a surface has been lost, many member functions return the error code DDERR_SURFACELOST. When you receive this error message, the first thing you have to do is to get your surface's memory back by calling the Restore member function. Restore simply reallocates the surface's memory, and you are then responsible for restoring its contents to what they were before the surface was lost. This usually means recopying the bitmaps that were in the surface before it was lost.

So far we have covered the basics of using DirectDraw in a C++ environment. In the next installment, we'll discuss how this functionality can be merged into a Win32 application using MFC. We will also discuss other topics related to using the MFC class structure, and we'll create a full-screen game. □

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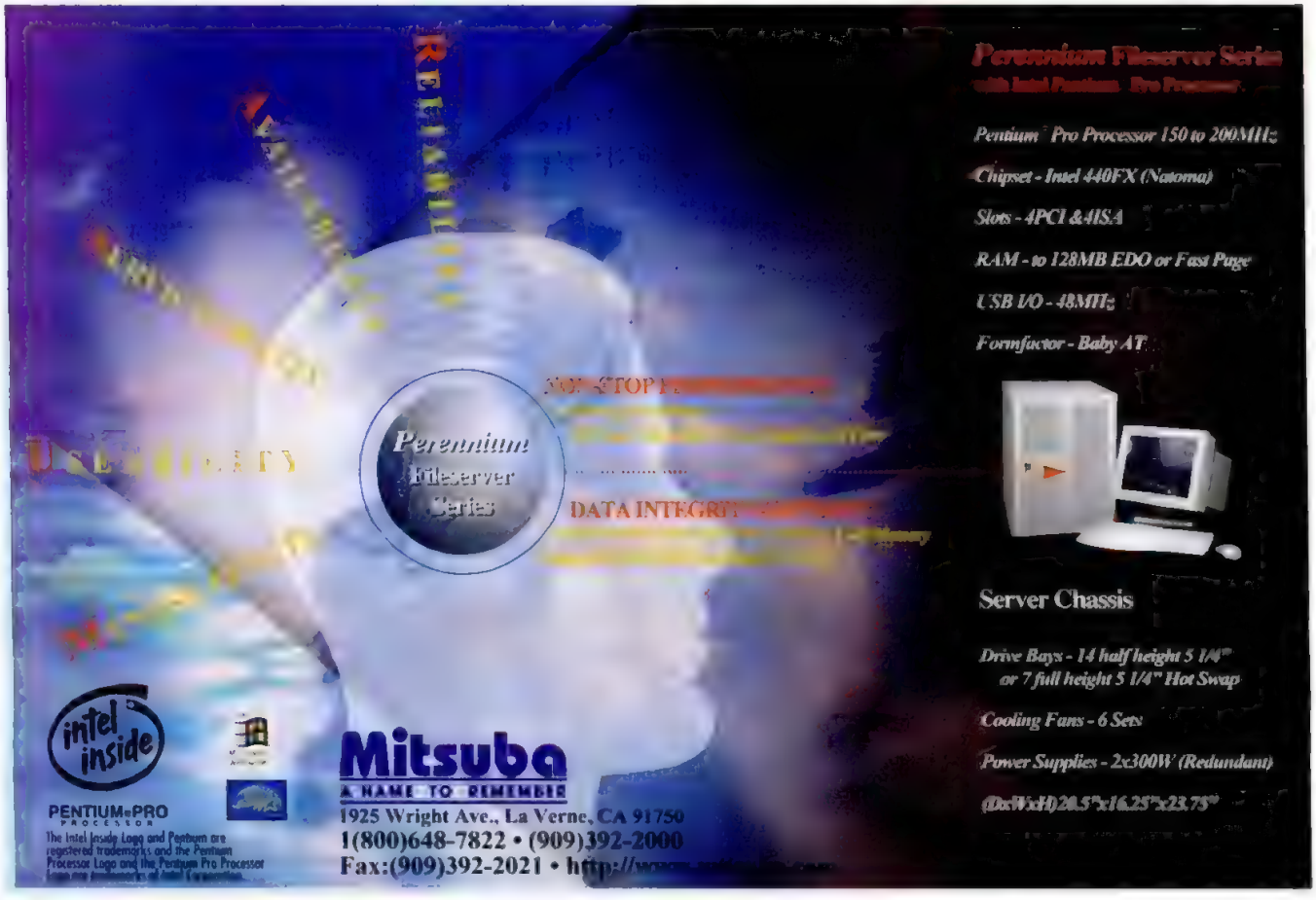

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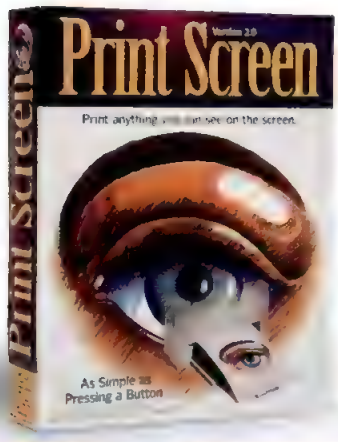

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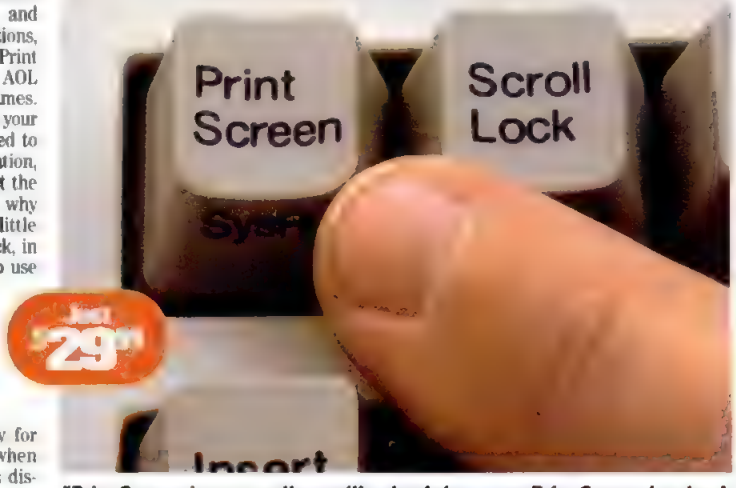

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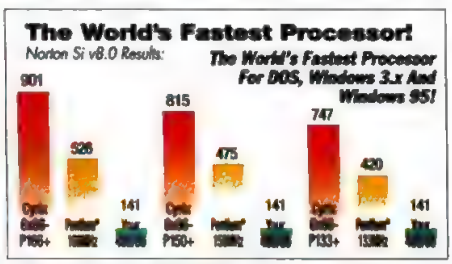

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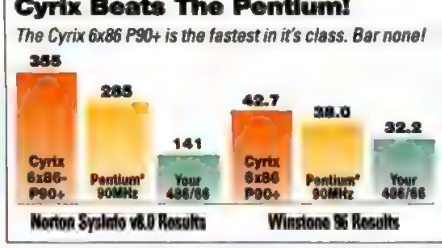

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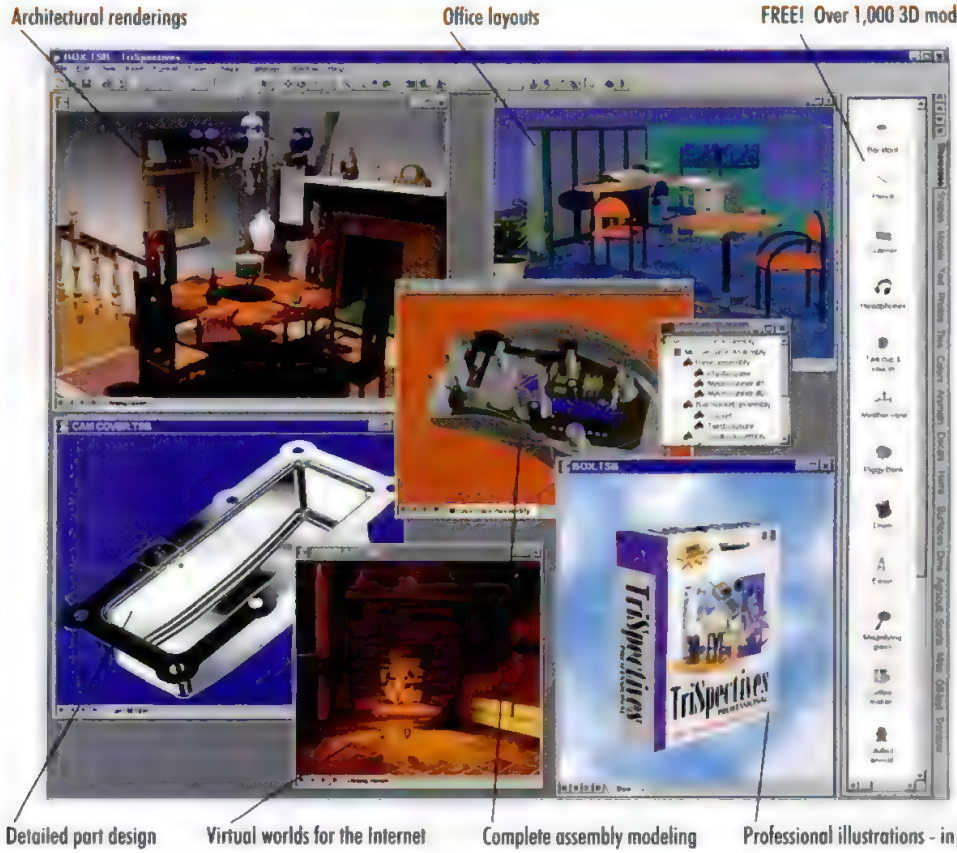

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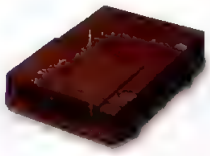

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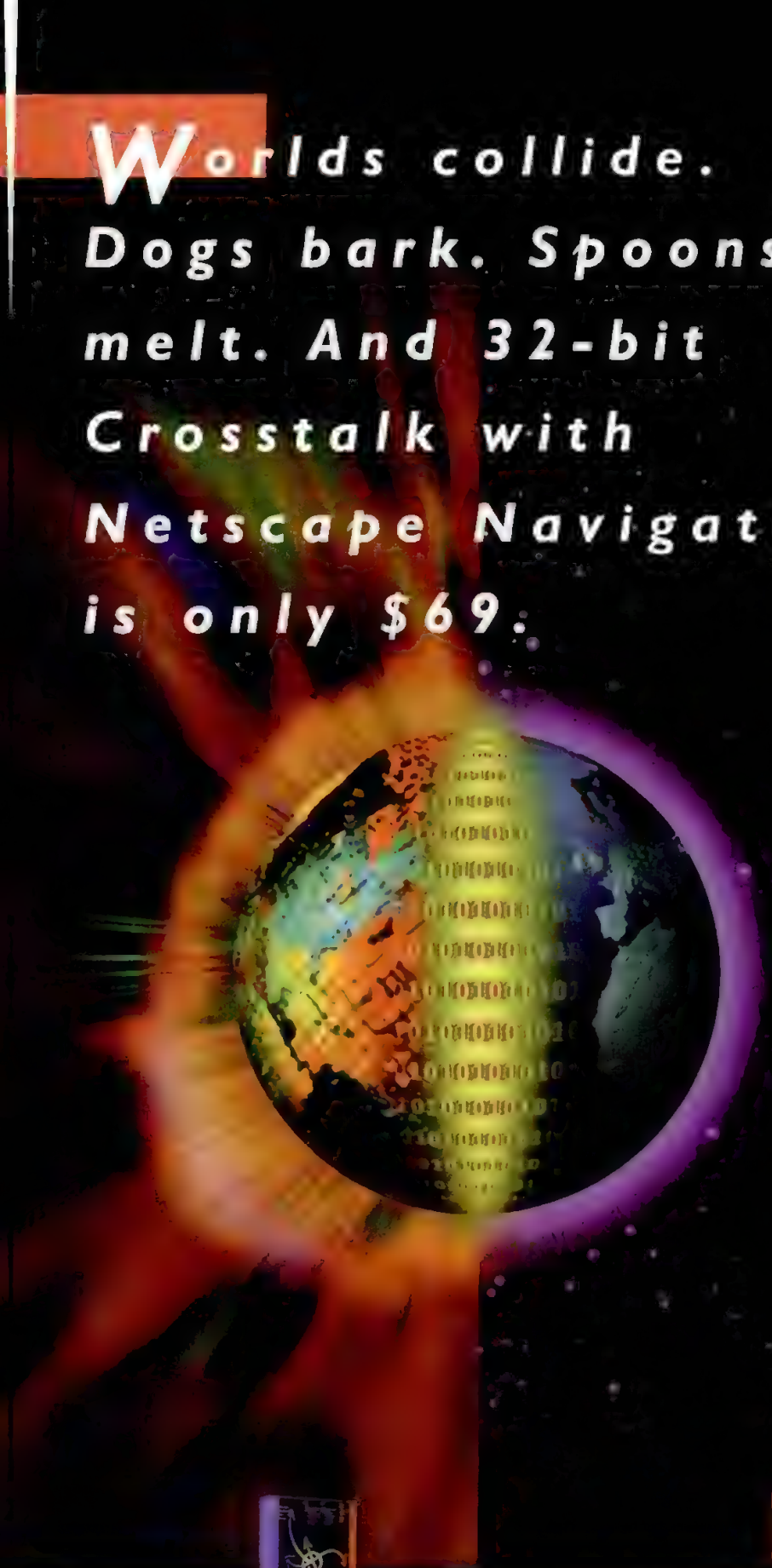

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By Linden deCarmo

More Multimedia Applications

Further explorations of multimedia in OS/2 using REXX.

In our last OS/2 column (June 11, 1996), we discussed using multimedia with REXX. We briefly reviewed the string interface (the English-like interpreter REXX uses to perform multimedia commands) before considering OS/2's multimedia components and how they can be used with REXX. Finally, we examined the CD-audio device and created the REXXBox, a REXX-based CD player. This time, we will explore the remaining multimedia devices in OS/2 and create an audio effects application and a multimedia jukebox (a program which can play MIDI, movie, wave, and CD-audio data).

DIGITAL AUDIO DEVICE

The digital audio (or wave) device is the second most heavily used driver in the system and is responsible for both playback and recording of digital audio. Unlike the Windows environment, in which the wave driver communicates directly with the audio hardware, in OS/2 all audio devices attach to an Amp-Mixer, which controls the audio device.

In order to use the wave device, the following steps are required:

- Open the device (with the OPEN command).
- Load the media (via the LOAD command).
- Perform actions (for example, CUT, COPY, PASTE, PLAY, or RECORD).
- Close the device (with the CLOSE command).

Like the CD device, the wave device (or driver) can be used by multiple applications simultaneously, a technique known as device sharing. To support device sharing, you can either open the device in shareable mode or use the release command to inform OS/2 that you wish to share the wave device (see Figure 1). If your REXX program does not have a Presentation Manager (PM) message queue, you should not support device sharing.

The OS/2 wave driver has another unique attribute: its ability to support many different file formats. For example, OS/2 Warp ships with support for the IBM/Microsoft .WAV file format and Creative Labs .VOC files, and the driver can be extended to support virtually any other audio format via Input/Output Procedures (or I/O Proc) DLLs. The Bonus Pack in OS/2 Warp contains three additional I/O Procs that enable OS/2 to play .AU (Unix or Internet audio), AIFF (Macintosh audio), and .IFF (Amiga audio) files. This flexibility frees REXX programs from being restricted to a particular operating system's audio files and also allows us to create a REXX-based multimedia jukebox.

SPECIAL EFFECTS WITH REXXTRACKS

Now that we've discussed the key features of the wave driver, we will build on these basic functions to create REXXTracks, a REXX-based digital audio effects machine. REXXTracks can record and manipulate sounds as well as exchange audio information with full-featured audio applications like the Digital Audio Editor.

```
rc = mciRxSendString("open waveaudio alias rexxtracks shareable wait",
➥'Retst', '0', '0')
rc = mciRxSendString("release rexxtracks wait", 'Retst', '0', '0')
```

FIGURE 1: *The first command opens the device in shareable mode. Alternatively, you can use the RELEASE command, which tells OS/2 that you'll allow other applications to use the wave device.*

```
rc = mciRxSendString("open waveaudio alias rexxtracks wait",
➥'Retst', '0', '0')
rc = mciRxSendString("load rexxtracks  max.wav wait", 'Retst', '0', '0')
rc = mciRxSendString("load rexxtracks  new wait    ", 'Retst', '0', '0')
rc = mciRxSendString("close rexxtracks wait", 'Retst', '0', '0')
```

FIGURE 2: *These commands open the wave device and then load a wave file called max.wav. The LOAD command is used again in line 3 to cause the wave driver to load a new file for recording.*

The first step REXXTracks takes is to open the device. Since it doesn't have a message queue, REXXTracks opens the device in exclusive mode and then, if successful, uses the LOAD command either to retrieve an existing audio file or to create a new one (see Figure 2).

If the user wants REXXTracks to create a new file, it must obtain digital audio data before it can create effects. To accomplish this, REXXTracks uses the RECORD command to create a wave file. When you open the wave device, it defaults to the recording options your sound card's manufacturer deems best for its hardware. Typically, the default mode is 16-bit, 22-kHz, mono audio. While this is acceptable for many uses, sometimes you'll want to record CD-quality (16-bit, 44.1-kHz, stereo) audio, in which case you should use the SET command to put the driver into CD-quality mode (see Figure 3).

Although most people will use the basic record options to record a wave file, you can also use advanced record commands to create unconventional effects. For instance, REXXTracks uses the FROM and TO options to jumble speech or music when recording. With this technique, you can create interesting party effects or a very crude scrambling tool.

Once REXXTracks has either recorded a new file or loaded an existing file, it uses the copy and paste clipboard operations to spice up the wave file (see Figure 4). By copying portions of the digital audio data into the clipboard and then strategically pasting the data into a file, you can make your speakers "stutter" or create eerie effects with music. You can also use the clipboard functions to exchange digital audio information with other multimedia applications. To get an idea of the possibilities, run REXXTracks, then start the digital audio player in the Multimedia folder. You'll see that REXXTracks leaves some odd effects in the clipboard for your entertainment!

Note that all clipboard operations (such as cut, copy, or paste) require a PM message

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```
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/* Record from line in jack */
rc = mciRxSendString("connector rexxtracks enable type line in wait", 'Retst', '0', '0')
/* Let user listen to what they are recording */
rc = mciRxSendString("set rexxtracks monitor on wait", 'Retst', '0', '0')
rc = mciRxSendString("set rexxtracks  bitspersample 16 wait   ", 'Retst', '0', '0')
rc = mciRxSendString("set rexxtracks  channels 2 wait         ", 'Retst', '0', '0')
rc = mciRxSendString("set rexxtracks  samplespersec 44100 wait", 'Retst', '0', '0')
rc = mciRxSendString("record rexxtracks  to 6000 wait         ", 'Retst', '0', '0')
rc = mciRxSendString("play rexxtracks  from 0 wait", 'Retst', '0', '0')
rc = mciRxSendString("close rexxtracks wait", 'Retst', '0', '0')
```

FIGURE 3: *This example shows how to use the SET command to prepare the wave driver for CD-quality recording. After the device is initialized, it records 6 seconds of high-quality audio.*

queue. If you attempt to use a multimedia REXX program containing clipboard functions directly from a command window, it will fail. Instead, you should start the REXX program from within PMREXX or another REXX product with a PM message queue.

OS/2 multimedia supports infinite undo and redo exactly for tasks like these. This feature gives you the ability to recover from an accidental cut, paste, or record command. Once you've saved a file, however, you can't undo any prior actions. Figure 5 illustrates how to handle a situation in which a clipboard function is called but no message queue is available, and shows how you can use undo to recover from a mistaken paste command.

After REXXTracks has finished customizing the wave file, you must use the save command in order to make the changes permanent. You can add, delete, or change portions of an audio file with OS/2, but none of these changes become permanent until your program saves the audio data. The combination of an unlimited undo/redo function and the ability to abandon changed files allows you to write a full-featured audio editor with REXX.

MIDI MADNESS

Besides the drivers for CD-audio and wave devices, OS/2 comes with support for Musical Instrument Digital Interface (MIDI) files and for digital video movie files. As we create the final program in this series, the video jukebox (VREXX), we'll explore how these devices work and give you some tips on how to use them.

While the MIDI device in OS/2 resembles the wave device, there are some variations. The most obvious, of course, is that the MIDI driver plays MIDI files (Figure 6), whereas the wave driver can play only digital audio files. In addition, the current version of the MIDI driver doesn't record and has no clipboard functions. As a result, you'll have to create your MIDI content in a standalone MIDI sequencer or obtain MIDI files from the Internet or elsewhere.

Although MIDI files are considerably smaller than wave files, they can sound as good as or better than an equivalent wave file. MIDI files contain a data stream that informs a MIDI device (your sound card or a synthesizer) how to 'perform' a piece: when to turn notes on and off and what sounds to use, for example. Since these instructions typically consist of 2 or 3 bytes per note (compared with 11,000 to 88,200 bytes per second for digital audio, depending on the sampling rate and bit depth), MIDI files are clearly less hungry for space on your hard disk.

Because MIDI files are so small, you might wonder why anyone would ever choose wave files. The fact is that speech and certain sound effects don't translate easily into MIDI messages. Moreover, many older sound cards, such as the Creative Labs Sound Blaster or Media Vision Pro AudioSpectrum 16, use a chip that plays MIDI files with a very synthetic, "computerlike" sound. Unless you have a modern wavetable sound card with samples of actual musical instruments, MIDI files may result in a sound noticeably inferior to a wave file.

But MIDI does have another advantage, besides its compact file size: It can be used to control devices ranging from fireworks controllers to roller-coaster schedulers. This is possible because the MIDI file format is not music- or synthesizer-specific; rather, it contains a generalized message format that can be used for myriad purposes. A general-purpose MIDI REXX example is beyond the scope of this article, but you can contact the International MIDI Association for additional information on the MIDI specification and file format.

DIGITAL VIDEO DEVICES

The digital video device is responsible for playing movies and is also accessible via REXX. While this driver is used primarily to play software motion videos (typically found in .AVI files), it can also utilize hardware-accelerated video devices, such as Sigma Designs' MPEG card. Like the audio driver, the digital video driver supports many file formats, including the Autodesk Animator's .FLC files and the Motion Picture Expert Group's MPEG format. VREXX, our video jukebox, takes advantage of this versatility by allowing users to play many popular movie file formats.

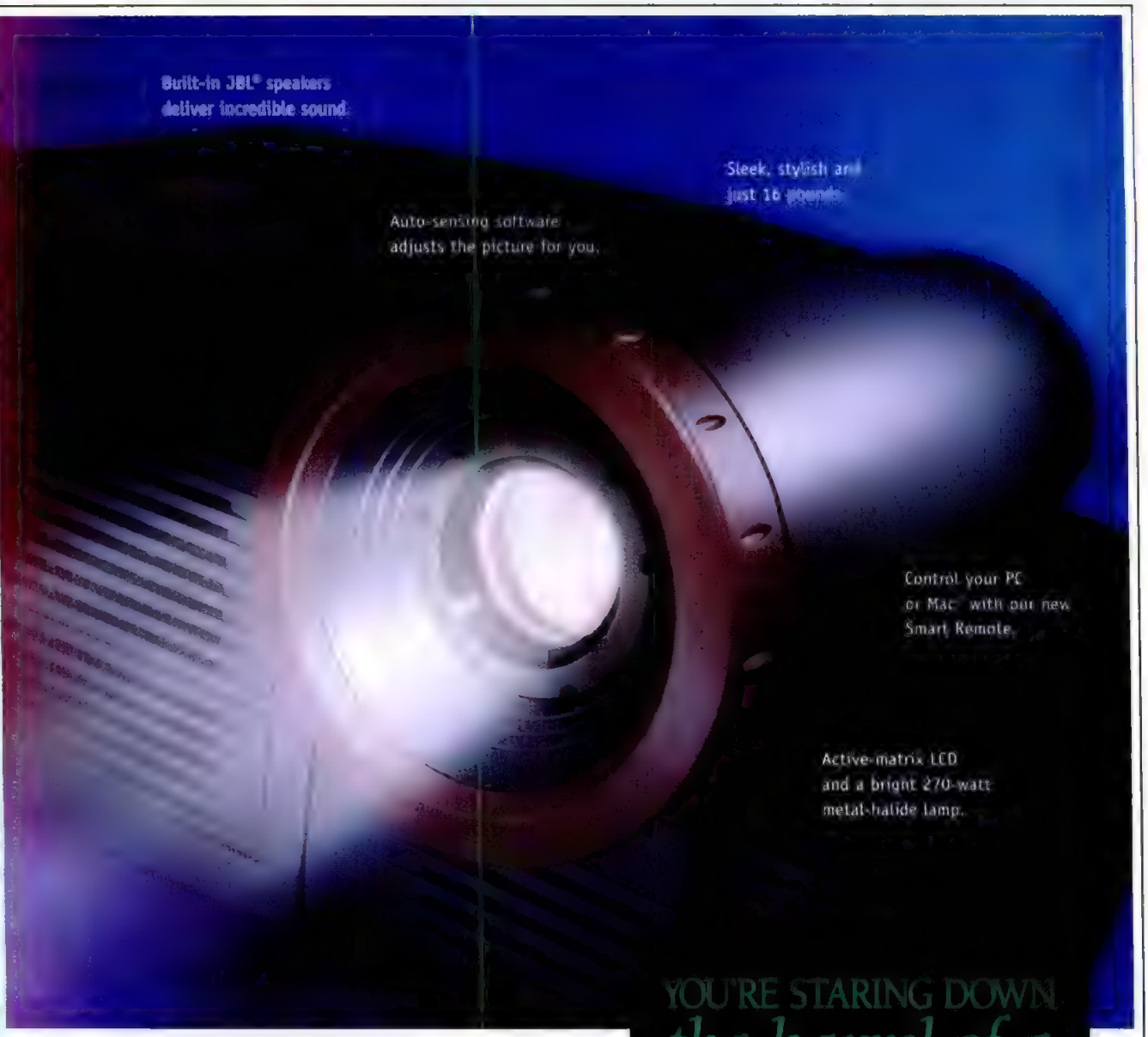
Since the digital video driver is dependent

```
rc = mciRxSendString("open d:\mmos2\sounds\laser.wav alias clipboard wait",
➥'Retst', '0', '0')
rc = mciRxSendString("copy clipboard from 0 to 3000 wait ",
➥'Retst', '0', '0')
rc = mciRxSendString("seek clipboard to end wait ", 'Retst', '0', '0')
rc = mciRxSendString("paste clipboard wait ", 'Retst', '0', '0')
rc = mciRxSendString("paste clipboard wait ", 'Retst', '0', '0')
rc = mciRxSendString("play clipboard from 0 wait ", 'Retst', '0', '0')
rc = mciRxSendString("close clipboard wait ", 'Retst', '0', '0')
```

FIGURE 4: *These statements illustrate how to place digital audio data into the clipboard and how to pull audio from the clipboard.*

```
rc = mciRxSendString("open new type waveaudio alias a wait",
➥'Retst', '0', '0')
rc = mciRxSendString("record a to 12000 wait ", 'Retst', '0', '0')
rc = mciRxSendString("cut a from 0 to 3000 wait ", 'Retst', '0', '0')
rc = mciRxSendString("undo a wait ", 'Retst', '0', '0')
rc = mciRxSendString("play a from 0 wait ", 'Retst', '0', '0')
rc = mciRxSendString("close a wait ", 'Retst', '0', '0')
```

FIGURE 5: *In this example we record 4 seconds of audio, cut out the first second, and then undo the cut operation.*



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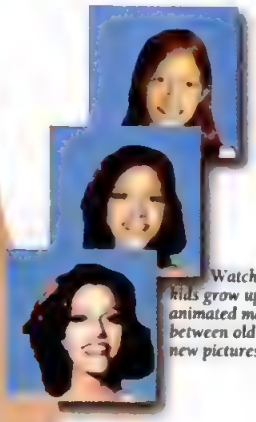

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```
rc = mciRxSendString("open d:\mmos2\sounds\bbee.mid alias mid wait",
➥'Retst', '0', '0')
rc = mciRxSendString("play mid from 0 to 35000 wait ", 'Retst', '0', '0')
rc = mciRxSendString("close mid wait", 'Retst', '0', '0')
```

FIGURE 6: *These lines illustrate how to play the first 12 seconds of a MIDI file.*

```
rc = mciRxSendString("open digitalvideo alias macaw wait ", 'Retst', '0', '0')
rc = mciRxSendString("load macaw d:\mmos2\movies\macaw.avi wait",
➥'Retst', '0', '0')
rc = mciRxSendString("play macaw wait ", 'Retst', '0', '0')
rc = mciRxSendString("close macaw wait ", 'Retst', '0', '0')
```

FIGURE 7: *These statements show you how to open the digital video device and play a movie. Like all REXX programs that use the digital video driver, this example must be run from PMREXX or another program with a message queue.*

on PM to display pictures, all REXX programs that use it must have a message queue (such as PM REXX). Figure 7 demonstrates how to open the digital video device and play a file.

Many people are confused by the fact that some software motion video (.AVI) files play under OS/2 but not under Windows, and vice versa. This confusion arises because .AVI files are really wrappers around different movie technologies called codec (compression/decompression) routines. By default, the OS/2 software motion driver has the ability to play the OS/2-specific codec Ultimotion. In addition, IBM ships support for Intel's Indeo 3.1 codec. By contrast, Windows uses the Cinepak and Microsoft Video codecs. To get these Windows .AVI files to work with OS/2, you can download a shareware package called apcodec from CompuServe, the Internet, or elsewhere (the latest version of this package is called apcodec5.zip and can be found at *ftp.cdrom.com* or other Internet sites).

Like the MIDI device, the current digital video driver shipped with OS/2 doesn't record. But if you install the Video IN package found in the OS/2 Bonus Pack, you can record movies with REXX and edit them as well, using the cut, copy, and paste operations discussed previously.

Since VREXX can play movies, MIDI files, wave files, and any other multimedia format supported by OS/2, it must switch seamlessly between devices. To accomplish the smooth transfer between drivers, the first thing VREXX does is open a device (such as the wave driver) with the OPEN command. After the driver is open, it can use the LOAD command to set up the device with different wave files. LOAD is the preferred method of bringing in a new file, since it is considerably faster than reopening the driver. But you can't initialize the wave device with a MIDI file or movie file, so you must close the driver and reopen the file with the appropriate driver .

Once a file is opened, VREXX asks the driver what type of media it uses and stores this information for future use. When the next file in the playlist arrives, VREXX attempts to load the file into the current device. If the driver indicates that the file contains an incorrect file format (by returning the invalid media type error), VREXX closes the driver, loads the file into the correct driver, and then plays the file (see Figure 8).

After VREXX determines whether it can open or load a file, it uses the play command to display a movie or play MIDI or digital audio files.

You can download VREXX and REXXTracks, along with enhanced versions of the figures accompanying this article, from PC Magazine Online. (See the sidebar "Guide to Our Utilities" in this issue's Utilities column for downloading instructions.)

Now that we've examined the basic features of all of the preinstalled multimedia devices in OS/2, you're probably anxious to see the documentation for more advanced multimedia functions. Alas, there is a dearth of information on multimedia and REXX. One additional source of information on REXX's string interface is the Multimedia Programmer's Reference found in IBM's Developer's Connection for OS/2, a quarterly CD that gives subscribers access to the latest programming tools and documentation for OS/2 development. You should be aware, however, that this product is geared primarily toward developers familiar with C or C++, and not necessarily the average REXX user.

OS/2 Warp Unleashed by David Moskowitz and David Kerr, published in 1995 by Sams Publishing, is another source of multimedia REXX information. This book is an excellent general reference for REXX, and the multimedia chapter has a number of REXX scripts you can use as building blocks.

In this series of articles, you've been armed with the information necessary to control the CD, wave, MIDI, and digital video devices. You've also been given some general guidelines on how multimedia should be used with REXX. I encourage you to use this knowledge to create dynamic, exciting multimedia REXX programs, and I look forward to seeing and hearing them in the future. □

Linden deCarmo is a software engineer for Motorola in Plantation, Florida. You can contact him at lindend@ibm.net.

```
rc = mciRxSendString("open waveaudio alias error shareable wait",
➥'Retst', '0', '0')
rc = mciRxSendString("load error d:\mmos2\movies\macaw.avi wait",
➥'Retst', '0', '0')
if ( rc <> 0 ) then
   do
   /* the upper 16-bits of an multimedia error is the device id--remove it
   * since we only care about the lower 16-bits.
*/
   if rc > 65536 then
     do
     temp = rc - 65536
     rc = temp
     end
   /* Invalid media type error is 5051 */
   if rc = 5051 then
     say "Wave driver can't play this file format"
   else
     do
     rc = mciRxGetErrorString(rc, 'errstr')
     say 'errstr is ' errstr
     end
   END
```

FIGURE 8: *This is an illustration of the correct processing of the LOAD command to detect media types.*

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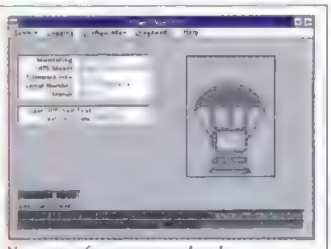

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	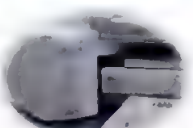		
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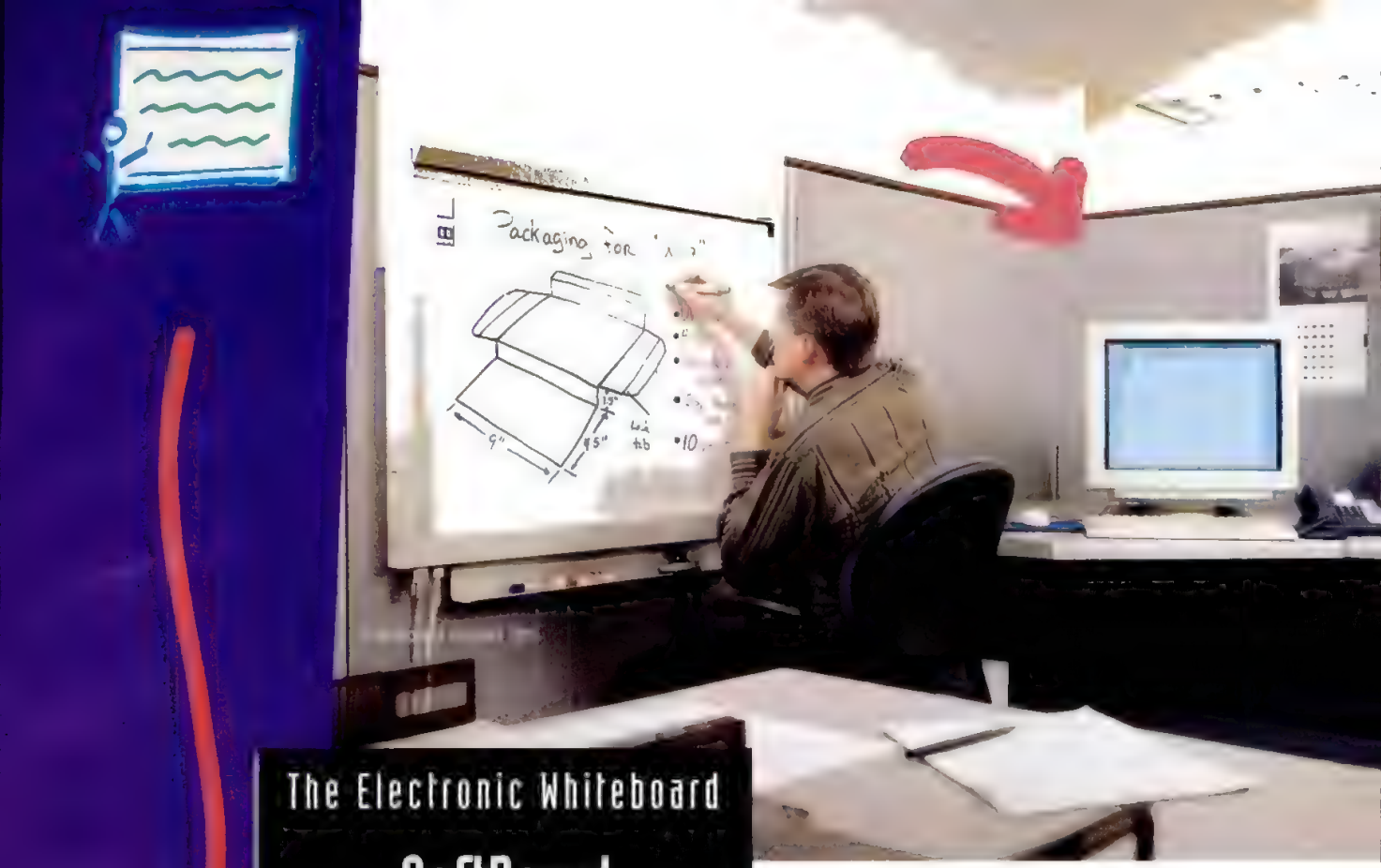

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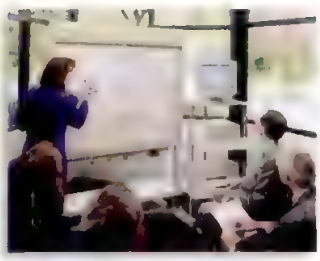

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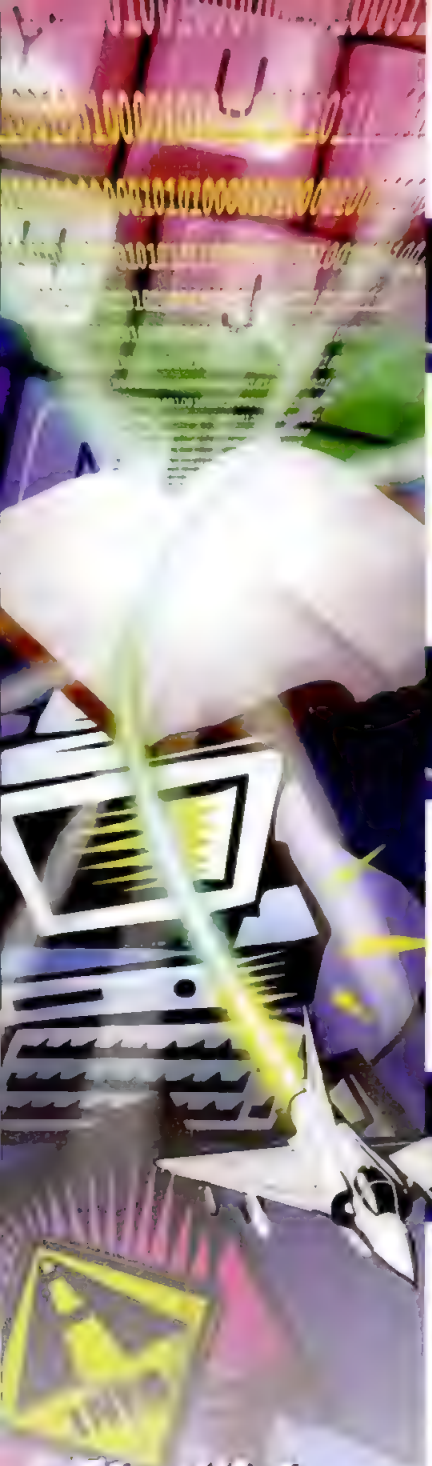

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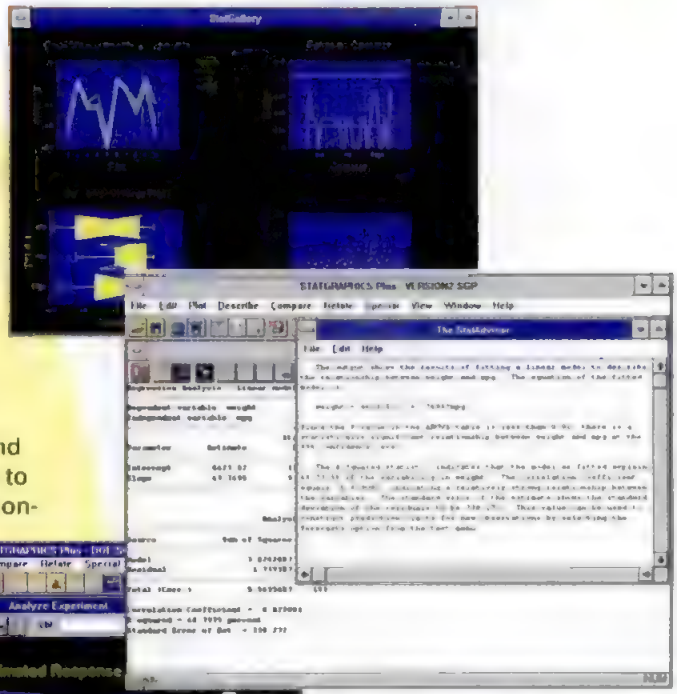

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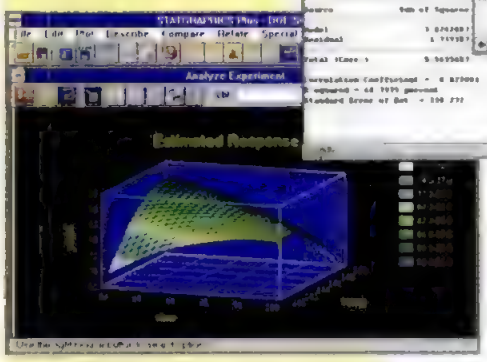

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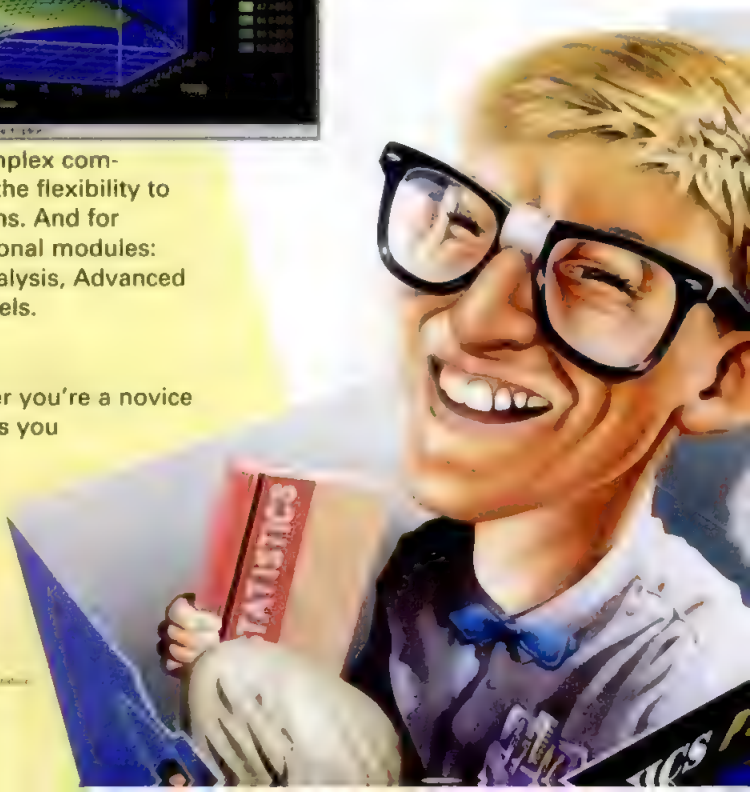

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CIRCLE 171 ON READER SERVICE CARD

By Neil J. Rubenking

Control Installations Under Windows 95

A new 32-bit version of InCtrl understands the registry and long filenames.

You just can't trust those installation programs. Sure, they'll copy a new application's essential files to the hard disk, but they'll also add files to existing directories, change .INI files, tweak the Registry, and generally litter the disk. Yes, Windows 95 includes an Add/Remove Programs applet in its Control Panel, but this applet is virtually powerless on its own. It can function only if the installation program includes an uninstall function and provides the applet with all necessary information. If the installation program is old or uncooperative, the Add/Remove Programs applet can't do a thing.

PC Magazine readers have used InCtrl 2 (and InCtrl before it) to track the system changes made by Windows 3.1 installation programs. You've consistently kept InCtrl in the "Top Ten" list of popular downloads. InCtrl 2 is a 16-bit program, however, and thus is not suited to tracking installations in 32-bit Windows (Windows 95 or Windows NT). It can't track the all-important 32-bit Registry, and it's unaware of long filenames. Bowing to popular demand, we've created InCtrl 3, which specifically targets 32-bit Windows.

InCtrl 3 handles long filenames, tracks changes to the Registry, and generally runs faster because it's a 32-bit program. By the same token, InCtrl 3 can be used *only* under Windows 95 or NT. In addition, its interface has been revised to add clarity and ease of use while providing more control.

You can obtain InCtrl 3 by downloading it from PC Magazine Online or by mail. (Refer to the sidebar "Guide to Our Utilities" for details.) The source code for InCtrl 3, which was written in Borland's visual programming tool Delphi, is provided for those interested in seeing how it works.

INSTALLING INCTRL 3

To install InCtrl 3, create a new directory and copy the files INCTRL3.EXE and INCTRL3.HLP to it. This directory is the default location for InCtrl 3's report files and also holds all of its temporary files. You may add INCTRL3.EXE to your Start menu, if you wish, or simply launch it from the Start menu's Run dialog as needed.

Being a 32-bit program itself, InCtrl 3 stores its own persistent data in the Registry. If you decide to remove it from your system, first issue the command

```
INCTRL3 CleanRegistry
```

either from a DOS box or from the Start menu's Run dialog. After doing this, you can simply delete InCtrl 3's directory and all the files it contains.

USING INCTRL 3

You don't install new programs every day. In fact, weeks may go by between installations. InCtrl 3 uses a step-by-step, wizard-style multi-page interface to save you from having to remember how to use it. The first page introduces the program, and each succeeding page asks a simple question. Buttons marked Next and Prev let you navigate back and forth among the pages. The Next button is enabled only when you have answered the current question appropriately. When you've answered all the questions, clicking on the Finish button initiates the installation.

IN THIS ISSUE

InCtrl 3

InCtrl 3 lets you track system changes made by Windows 95 and Windows NT installation programs.

InCtrl 3 lets you decide just how much control you want over the installation-tracking process. Five of the question pages have a check box at the bottom labeled "Skip this page in the future." When you have checked a page's skip box, InCtrl 3 skips over that page each succeeding time you run it, reusing whatever value you previously entered. To see all pages, including those whose skip boxes are checked, check the "Show all pages" box on the first page. By arranging to skip pages whose answers rarely change, you can simplify the process of using InCtrl 3. And the show-all-pages option provides a safety net in case you change your mind about skipping a particular page.

Most of the on-screen elements have Windows 95–style pop-up help. To invoke pop-up help for a particular component, either click on it after clicking the question-mark icon on the title bar or right-click on it and select "What's This?" from the menu. Figure 1 shows the first question page, on which you specify which installation program you want to launch. The pop-up help for the Next button is displayed.

If you leave the installation program name blank, InCtrl 3 will operate in two-phase mode. In this mode, InCtrl 3 terminates after collecting information about the system. You perform the installation, then run InCtrl 3 again to get a report on system changes. You can use this mode to take advantage of the Windows 95 Add/Remove Programs applet without risk. If the installation program cooperates, you can use the same applet to remove it. If not, you still have the InCtrl 3 report handy. And of course, if a particular installation program proves to be incompatible with InCtrl 3, you can use two-phase mode to avoid a conflict.

In most cases, however, you'll enter the installation program's name in the upper edit box or click on the Browse button to select it from a standard file dialog box. When you've entered the name of an existing executable file, the Next button will become enabled. Note that for InCtrl 3's purposes, the .INF files used by some programs for installation are considered to be executable. In the rare event that the installation program requires command-line switches, you can enter those in the lower edit box.

The next page asks for a descriptive name, which will be included in the report file that InCtrl 3 generates. Don't skip this step! You may find yourself examining the report many months later, so the more thorough your description, the better.

On the following page, InCtrl 3 offers a unique numeric filename for the report (see Figure 2). You can either accept this filename or click on the Select button to choose another name. The Next button will be disabled if you choose a file that's not on a hard disk or

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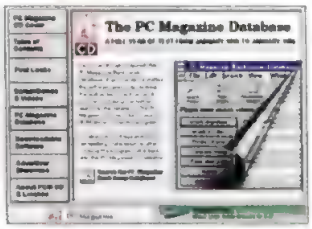

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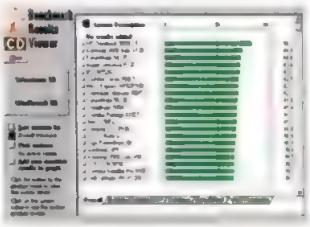

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CIRCLE-061 ON READER SERVICE CARD.

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Designed for Microsoft® Windows 95 — Microsoft Windows Compatible

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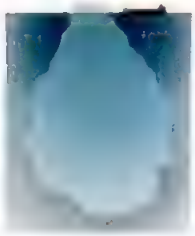
Of course, with other deletion programs you can have the experience of getting rid of things you never meant to get rid of. Which may be good for us, but bad for you.



It's what you don't see on your hard drive that causes problems. Every application puts bits and pieces of itself in places you don't know about. Without UnInstaller, things can slow down — or come to a screeching halt.

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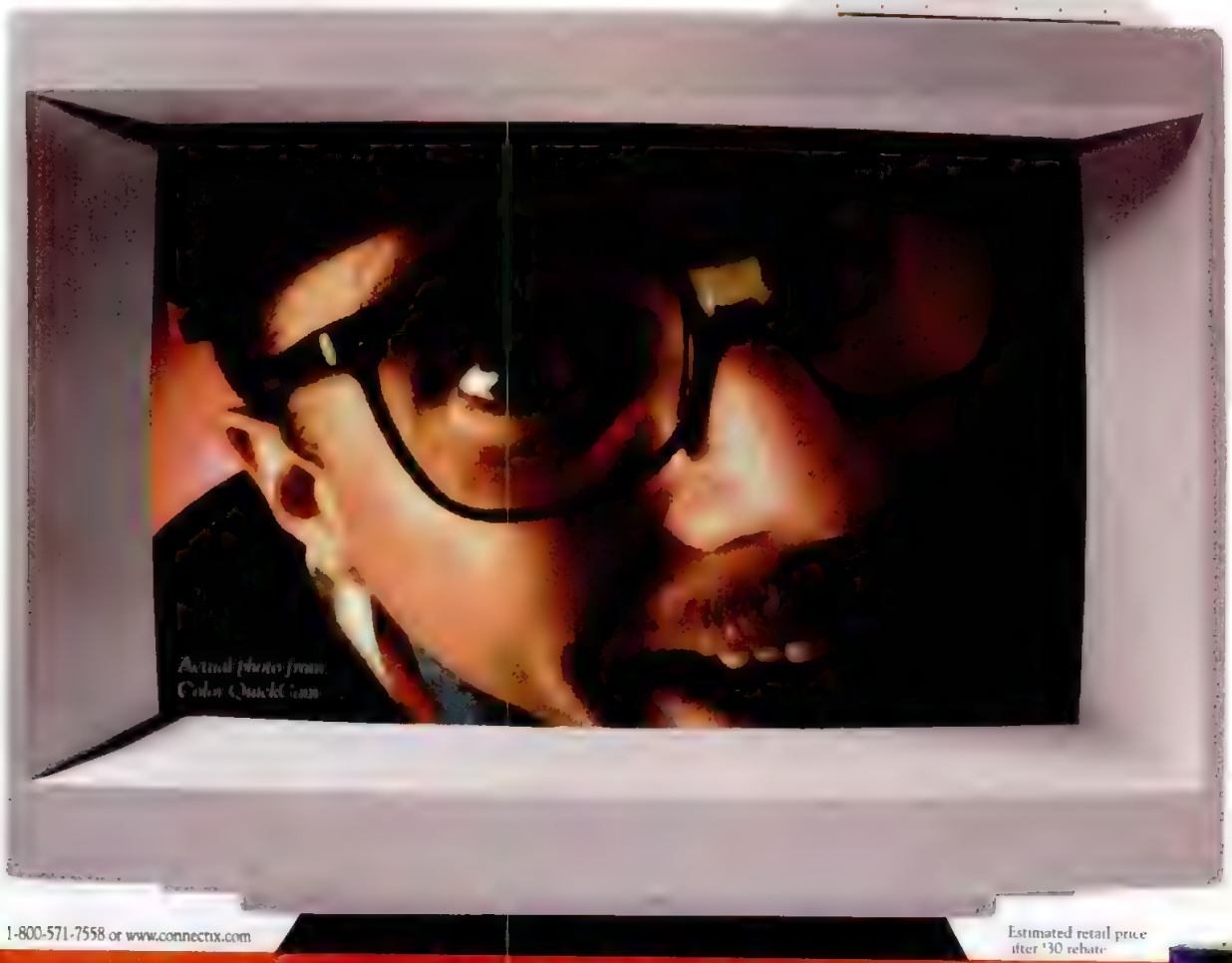

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network drive. If you're satisfied with InCtrl 3's numeric filenames, you can suppress this page in the future by checking the skip box. Again, if you need to regain access to a skipped page, you can always select the show-all-pages option on the first page.

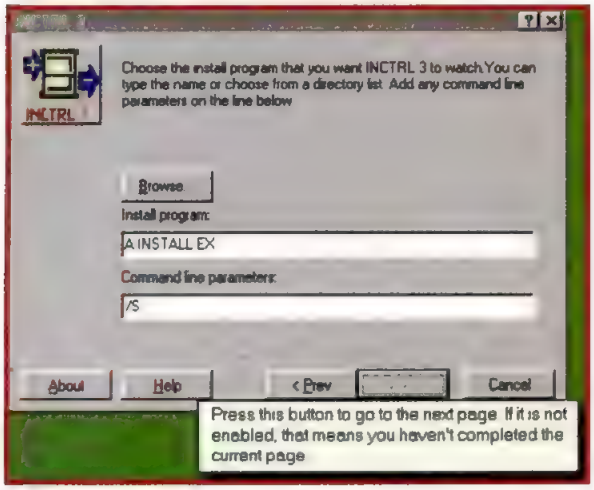

FIGURE 1: *InCtrl 3 asks a series of questions about the installation process; most on-screen elements have pop-up help.*

Now you must decide whether to track files by examining the target disk's file structure before and after the installation and noting the differences (disk-contents comparison) or by simply checking for files with date/time stamps after the start of the installation (file-time comparison). Disk-contents comparison is the default. It's the slower of the two methods and requires an appreciable amount of temporary disk space to record the file layouts before and after the installation, but it dependably reports on files and directories added to or deleted from the system as well as on files whose sizes or date/time stamps have changed.

The file-time-comparison method doesn't store any information about the target disk's file structure. It simply looks for files whose creation time or last-write time is after the start of the installation. This would not work in 16-bit Windows, where copying a file doesn't change its DOS date/time stamp. But 32-bit Windows maintains the creation and last-write times separately, and copying a file does update its last-write time.

File-time comparison is inherently not as reliable as disk-contents comparison. It can't distinguish new files from changed ones, and if the system clock is set incorrectly or any files have erroneous dates, it can produce incorrect results. Use this method only if you're short on disk space or very short on time. If you'll always want to use the tracking method you've selected, check the skip box on this page.

Longtime fans of InCtrl will miss the super-speedy Fast File Notification tracking mode, in which an undocumented function coerces Windows itself into notifying InCtrl of every change to the file system. InCtrl 3 can't offer Fast File Notification because this undocumented function is no longer present in Windows 95 and doesn't work on NTFS drives under Windows NT.

The next page lets you avoid tracking drives and directories that you know won't be changed by the installation. The scrolling list includes a button and two labels for each drive. On each button is an icon representing the type of storage medium: hard disk, removable disk, network drive, CD-ROM, or RAM disk. Installing onto a CD-ROM drive or RAM disk makes no sense, so buttons for these types are disabled. To the right of each button is one of three words: YES, NO, or DIR>. YES means the entire drive will be tracked, and NO means the drive will not be tracked at all. DIR> means that files in a selected directory and its subdirectories will be tracked, and the directory name appears just after the DIR> label.

Initially, removable disks are set to NO and hard disks and network drives to YES. Clicking on a button causes it to cycle through the three possibilities: DIR> becomes NO, NO becomes YES, and YES becomes DIR>. When you click on a button for a drive set to YES, a pop-up window appears that lets you choose the directory (see Figure 3). Suppose you're installing to drive D: and Windows resides in C:\WINDOWS. You'd set drive C: to track just the C:\WINDOWS directory, set drive D: to YES, and set any other drives to NO. If you have only one disk drive, or if you'll always want to track the same set of drives and directories, you can check the skip box on this page after you've made your choices.

The next page lists .INI files that InCtrl 3 will track. This list initially contains WIN.INI and SYSTEM.INI. Windows 95 still uses these files, although many of their functions have been transferred to the Registry. You can delete one or both of them or add other .INI files to the list. And of course, if you anticipate tracking the same set of .INI files for each installation, you can check the skip box on this page when you've adjusted the list to your satisfaction.

The next page is skipped by default—it won't show up unless you've checked the "Show all pages" box. It lists, in read-only form, the Registry keys that InCtrl 3 ignores. These are keys whose data changes without program intervention. If a change occurs while InCtrl 3 is running an installation program, it would be reported as a change caused by the installation program. Even so, background programs on your system may make changes to the Registry while InCtrl 3 is running, and those changes will show up in the report as well. There's nothing we can do about that.

That's it. You're ready! The final page lists the choices you've made and a Finish button has taken the place of the Next button. Look closely at the reported choices; if any is incorrect, you can go back (using the Prev button) and correct it. When everything is ready, click on Finish. InCtrl 3 will shrink to a small, always-on-top window and begin recording preinstallation system data. Just so you'll know it's not idle, it keeps the small window updated with a report of what it's doing. If for some reason you decide not to go through with the installation, click on the Abort: No Install button. Once the installation program has been launched, however, it can't be unlaunched, so at that point this button changes to Abort: No Report.

Now the installation program is in charge. Follow its instructions, answer its questions, and feed it disks, if necessary. When the installation program ends, InCtrl 3 will beep and present the message "Install may be complete." This means that the installation program launched by InCtrl 3 has terminated. But since that program may have launched a secondary installation program, InCtrl 3 can't be sure the entire process is done. You, the user, are the final arbiter. When you see that the installation is truly complete, click on the Install Done: Report button. InCtrl 3 will gather its postinstall system information, generate a report of changes, and preview the report on the screen. The report file is a plain-text file that you can view or edit at any time.

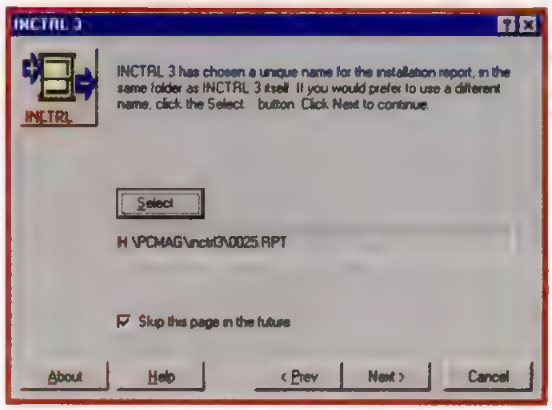

FIGURE 2: *If you're happy with InCtrl 3's unique numeric filenames, you can choose to skip this page.*

If the installation program restarts Windows, perhaps to activate a new driver, that won't stop InCtrl 3. When Windows restarts,

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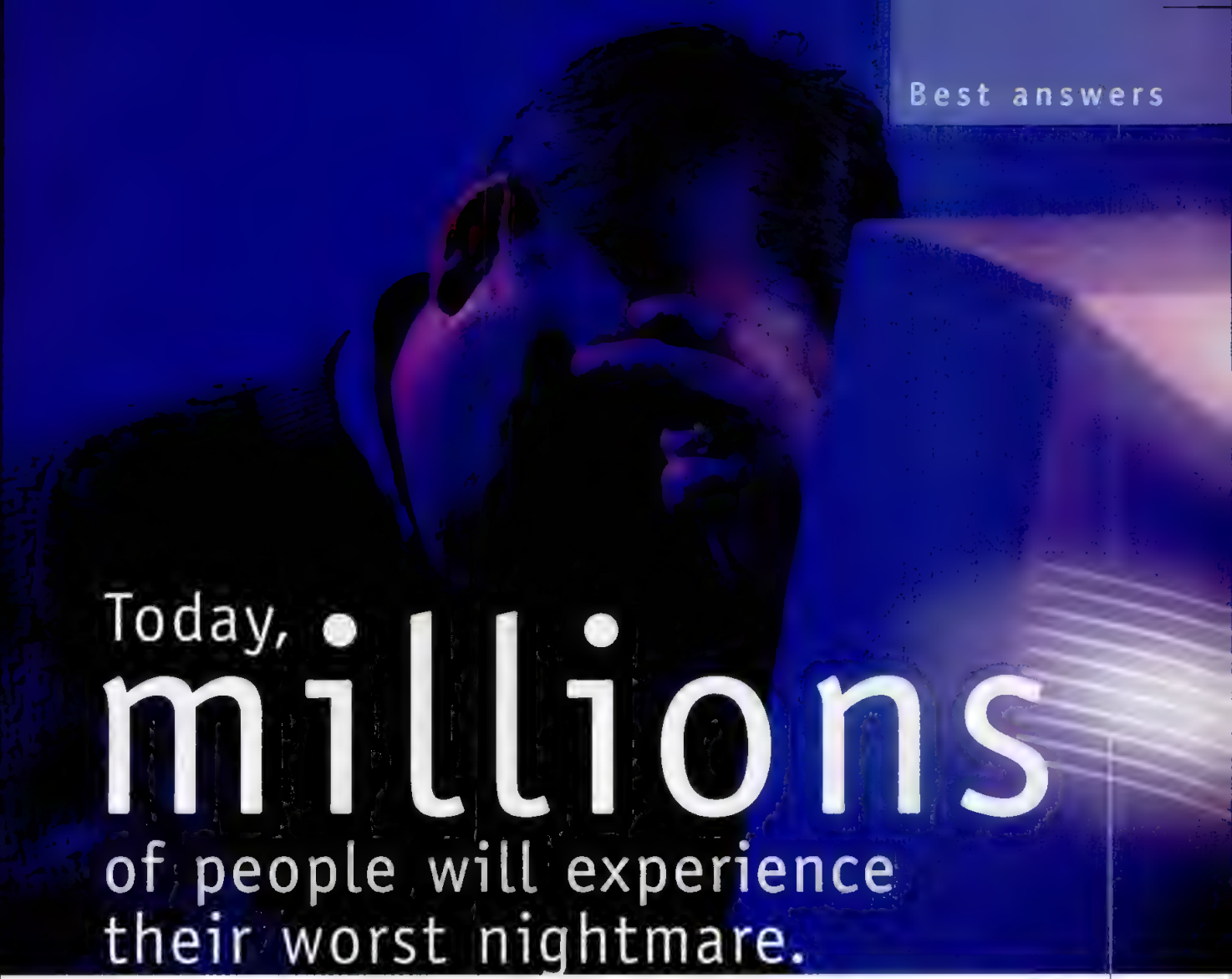

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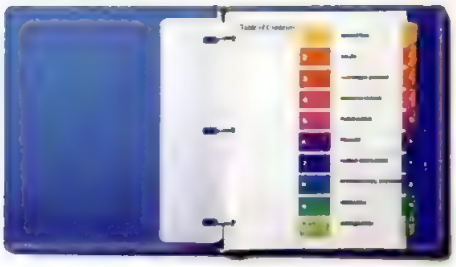

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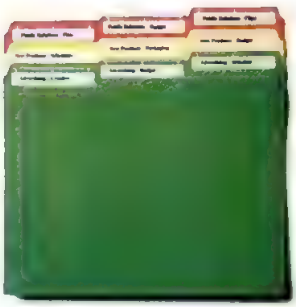

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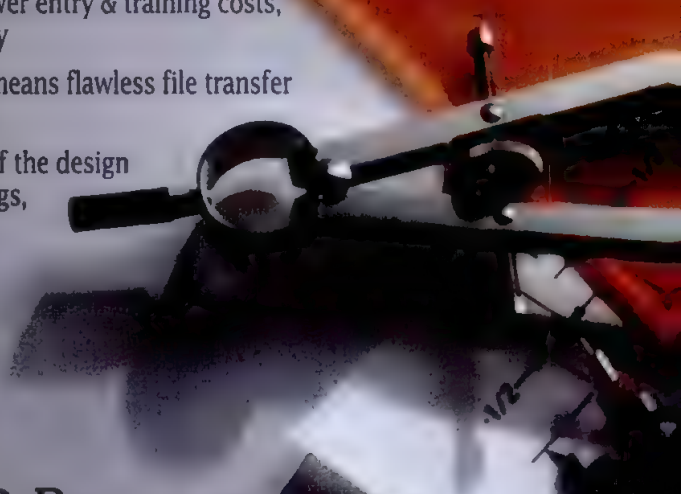

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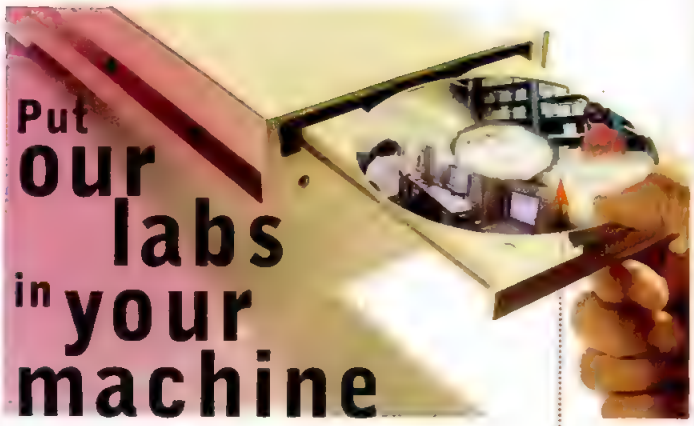

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InCtrl 3 restarts as well. As soon as the installation is complete, just ask for your report. Or, as noted previously, you can omit the installation program name to run in two-phase mode. If you do, InCtrl 3 will terminate after gathering the preinstallation information, which will allow you to run the installation program with no trace of InCtrl 3 in memory. When the installation is complete, run InCtrl 3 again to permit the postinstallation information gathering and comparison.

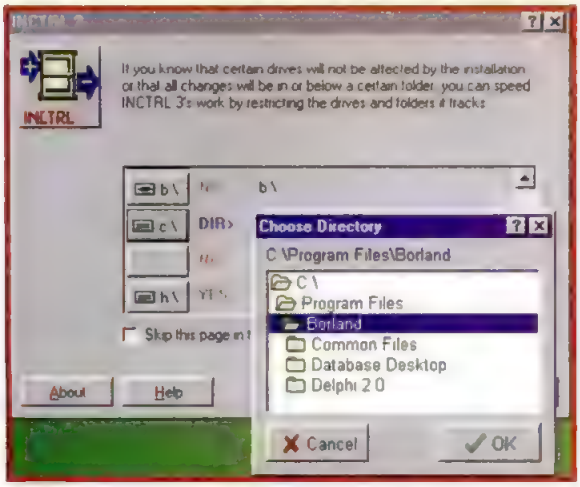

FIGURE 3: *By carefully controlling which drives are tracked, you can speed up InCtrl 3's recording of the file system.*

UNINSTALLING PROGRAMS

InCtrl 3 does not presume to replace utilities such as CleanSweep, Remove-It, or UnInstaller 3. It simply provides you with the information needed to handle removing programs yourself. Be cautious in your use of the InCtrl 3 report! Don't wildly attempt to delete all added files, restore all changed Registry keys, or remove all added .INI file data. It's quite possible that another program installed after the one you're removing relies on some of those system elements.

If you used the disk-contents-comparison tracking method, the report lists added and deleted files and directories along with changed files. You can't bring back deleted items or restore changed files, but you can delete files and directories that have been added. If the installation program adds a whole directory, it's almost always safe to delete all the files it adds within that directory. Any remaining files may be data you have created using the program; don't delete these without examining them.

Files added to an existing directory, such as the Windows or System directories, can't necessarily be deleted with impunity. Other programs installed later may rely on them, but since the files were already in place, the other programs' installation reports won't show them. Rather than deleting these files, rename them, or move them to a "holding" directory. After you have determined that your other programs still run correctly, you can archive the files to floppy disks or delete them.

Similar advice applies to .INI files and Registry keys. If a program adds its own .INI file, its own section to an existing .INI file, or a new branch to the Registry, you can normally delete the entire file, section, or branch. If it adds keys to an existing .INI file section or to the Registry, it's possible that other programs are relying on those keys. To be safe, don't delete them. Comment out .INI file keys by adding semicolons at the start of the appropriate lines. You can't literally comment out a Registry key or value, but if you rename it to begin with a semicolon, you'll effectively remove it from circulation. And if an .INI key's value or Registry value's data was changed, don't just change it back. For .INI keys, make a duplicate of the line, comment out the original, and change the duplicate. For Registry keys, create a new key with the same value(s), rename the original, and change the duplicate. As before, check to make sure your other programs work before making your changes permanent.

PROGRAMMING INCTRL 3

The most essential change from InCtrl 2 to InCtrl 3 was the move from 16-bit to 32-bit programming. Direct effects of this move include the ability to track the 32-bit Windows Registry, support for long filenames, and faster execution. The enhanced functions in Delphi 2.0 and the 32-bit Windows API also allowed some streamlining of code. For example, Delphi 2.0 adds a Trim function that trims any number of spaces or control characters from the start and end of a string, replacing a dozen lines of Delphi 1.0 code. InCtrl 3's .INI file processing was vastly simplified by the new ability of the GetPrivateProfileStrings function to return a list of all sections in the .INI file. And whereas InCtrl 2 went to great lengths to categorize the installation program (32-bit Windows .EXE, 16-bit Windows .EXE, DOS .EXE, and so on), InCtrl 3 gets that same information with a 32-bit Windows API call.

TRACKING LONG FILENAMES

To determine what files and directories have been added, deleted, or changed, InCtrl 3 records each specified drive's or directory's file structure. For this purpose it uses a standard recursive function that uses the FindFirst and FindNext commands to fill a variable of type TSearchRec repeatedly with file information. Modifying this function to use long filenames was a snap, as the Delphi 2.0 TSearchRec structure includes the long filename.

The biggest difficulty in moving to long filenames involved finding code that made assumptions about the length of filenames. For example, InCtrl 2 could safely allocate pre-

```
unit pdthdu;
interface
uses Windows, Classes;
type
  TProcDoneThread = class(TThread)
    ProcHandle : THandle;
    Constructor Create(vProcHandle: THandle; OnTerm:
TNotifyEvent);
    procedure Execute; override;
  end;

implementation

constructor TProcDoneThread.Create(vProcHandle: THandle;
  OnTerm: TNotifyEvent);
begin
  Inherited Create(False);
  ProcHandle      := vProcHandle;
  OnTerminate     := OnTerm;
  FreeOnTerminate := True;
end;

procedure TProcDoneThread.execute;
begin
  WaitForSingleObject(ProcHandle, INFINITE);
  CloseHandle(ProcHandle);
end;

end.
```

FIGURE 4: *Like every TThread descendant, this object has an Execute method that defines what it does.*

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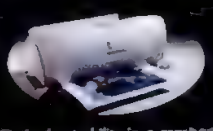

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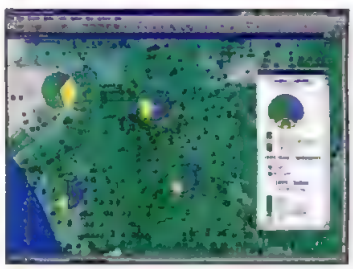

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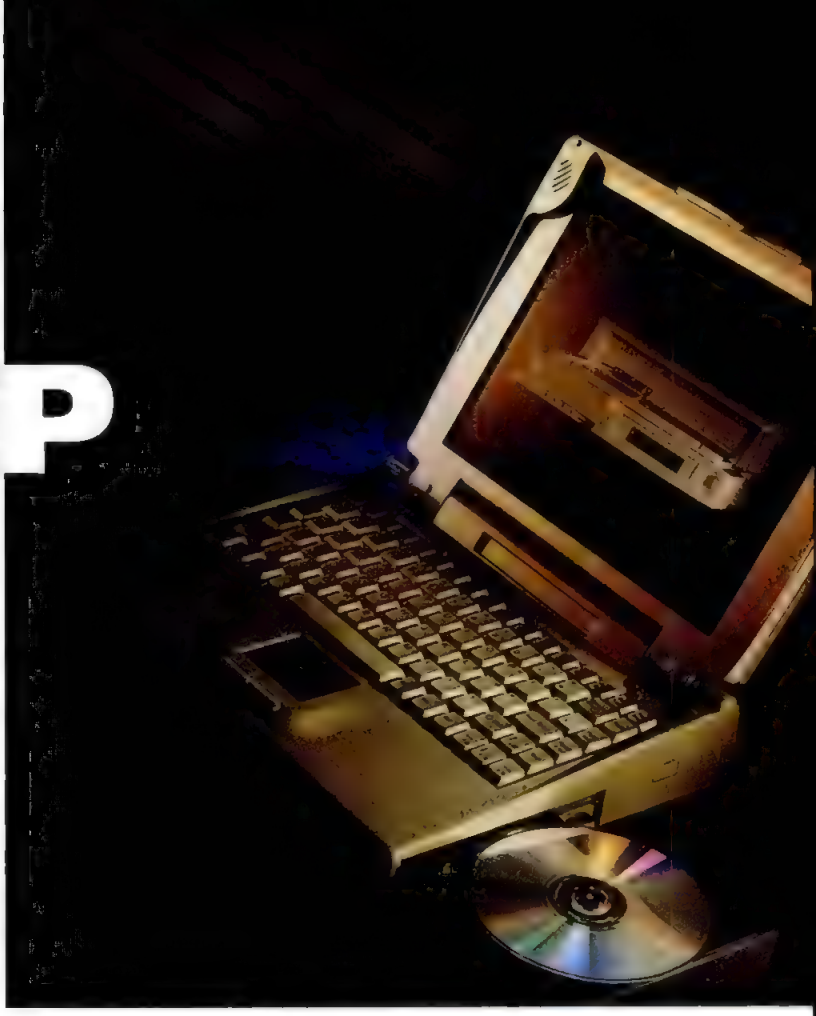

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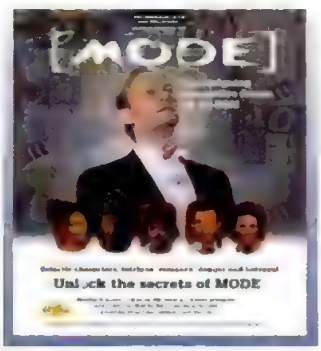

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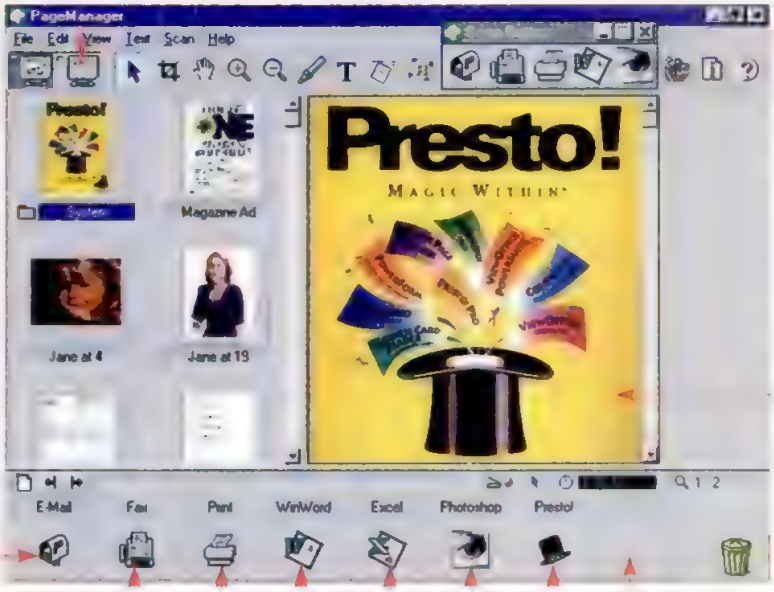

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CIRCLE 078 ON READER SERVICE CARD

cisely 11 characters to store each filename: 8 for the name and 3 for the extension. InCtrl 3 has to use a different layout because filenames can have up to 255 characters.

The first character of each line in the output file is a number indicating the subdirectory level. The starting directory, which may or may not be the root directory, has a level character of 0, its subdirectories have level 1, and so on. The next four characters are derived by mathematically combining the date/time stamp of the file and its size and converting the result into a printable string. InCtrl 3 calculates this four-character string before and after the installation program runs. If the two strings are not the same, the file was changed during the installation process. The remainder of each line is the filename itself.

Every long filename has a unique short filename, so you might think InCtrl 3 could save space by storing only the short filenames. However, if it did so there would be no way to report the long filename of a deleted file. The only way to get from a short filename to the corresponding long filename is to pass the short name to the FindFirst function and check the long filename of the result. That won't work if the file is no longer present.

A 16-bit program that calls FindFirst gets back a single date/time stamp in its TSearchRec. A 32-bit program gets three additional date/time stamps, representing the file's creation time, the last time the file was modified, and the last time the file was accessed. When InCtrl 3 is running in file-time-comparison mode, it finds new and changed files by looking for files having a valid (nonzero) creation or last-write time that is after the beginning of the installation process. Another recursive function walks the directory structure of the selected drives and directories, adding all such files to the output report.

THE REGISTRY

A 32-bit Windows program stores persistent data in the Registry rather than in private .INI files. Delphi 2.0's TRegistry object defines methods to handle every Registry manipulation task. Its descendant object TRegIniFile adds to these a set of methods that precisely correspond to the methods of TIniFile. TIniFile handles access to an .INI file; TRegIniFile handles access to a branch of the Registry as if it were an .INI file. This fact makes it simple to write code that will store persistent data when compiled under either Delphi 1.0 or Delphi 2.0. For example:

```
{$IFDEF Win32}
WITH TRegIniFile.Create('Software\PCM
\MyProg\1.0') DO
{$ELSE}
WITH TIniFile.Create('MYPROG.INI') DO
{$ENDIF}
 try
  S := ReadString('Section', 'Key',
                  'Default Value');
 finally
  free;
end;
```

InCtrl 3 uses both the TRegistry object and the TRegIniFile object.

Each Registry key can contain one or more values and one or more subkeys, so the structure is similar to that of a directory tree. It's no surprise, then, that the Registry data is stored in roughly the same way as the file-structure data. Each line of an InCtrl 3 Registry data file starts with a character indicating the item's depth in the hierarchy. The next character reflects the item's type: 0 for a key name, 1 for a key value, and 2 or greater for key value data. The remainder of the line holds the key name, value name, or value data.

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7. **WSWIN** Enhanced search tool
8. **1MBFORT** Fortifies low memory
9. **APPOIN** Windows appointment book
10. **INCTRL2** Controls Windows installs

The RegEdit accessory can save a branch of the Registry to a text file, but these files are much larger than necessary. InCtrl 3's level-based storage system avoids redundantly storing a key's name in each of its subkeys. To save space further, InCtrl 3 stores no more than 16 bytes of a binary value. If the value contains more than 16 bytes, the remaining bytes are XORed into the first 16. The result is a set of 16 bytes that will almost certainly be different if any part of the binary data has been changed.

While a disk has just one root directory, the Registry in Windows 95 has six "root keys." It's not necessary, however, for InCtrl 3 to track all six. The HKEY_CURRENT_USER root key is actually a branch of HKEY_USERS, and both HKEY_CURRENT_CONFIG and HKEY_CLASSES_ROOT are branches of HKEY_LOCAL_MACHINE. HKEY_DYN_DATA contains dynamic data that doesn't need to be tracked. So by storing HKEY_USERS and HKEY_LOCAL_MACHINE, InCtrl 3 gets all the necessary information. A similar relationship holds among the root keys of the Windows NT Registry.

InCtrl 3 stores its own persistent data in the Registry key HKEY_CURRENT_USER\Software\PC Magazine\InCtrl\3.0. That's how it remembers which skip boxes you've checked, for example, and which tracking mode you chose the last time you ran the program. More importantly, InCtrl 3 relies on the Registry to help it restart if an installation program restarts Windows. If a WM_ENDSESSION message occurs while InCtrl 3 is tracking an installation, InCtrl 3 adds its own executable name as the data for a value of the predefined RunOnce key, which resides in the Registry key that represents the current Windows version. InCtrl 3 stores this key's name in a variable called CurVerKey. Under Windows 95, this is HKEY_CURRENT_USER\SOFTWARE\Microsoft\Windows\CurrentVersion; under Windows NT, it is HKEY_CURRENT_USER\SOFTWARE\Microsoft\Windows NT\CurrentVersion. In either case, when Windows restarts it runs all programs listed under the RunOnce key and then removes them from the list. These few lines of code cause InCtrl 3 to rise from the dead:

```
WITH TRegIniFile.Create(CurVerKey) DO
 try
  WriteString('RunOnce', 'InCtrl 3',
              Application.ExeName);
 finally
  Free;
end;
```

InCtrl 3's about box also picks up handy information from the Registry. The registered owner and registered company name are stored as values in CurVerKey. Under Windows 95, the CD-ROM ID number is also stored there. And determining whether a math coprocessor is present involves checking a key under HKEY_LOCAL_MACHINE.

PROCESSES AND THREADS

When the installation program terminates, InCtrl 3 announces that fact by displaying the message "Installation may be complete." This is done by use of a thread that waits silently in the background until the installation program terminates, then triggers an event back in the main program.

A 32-bit program can nominally launch another program using WinExec, ShellExecute, or the modern CreateProcess. In 32-bit Windows, however, WinExec and ShellExecute are nothing more than wrappers around CreateProcess, and they hide much of the useful information returned by CreateProcess. For this reason, 32-bit programs should always call CreateProcess directly to launch other programs. If the CreateProcess call in the Exec Install method succeeds, the TProcessInforma-

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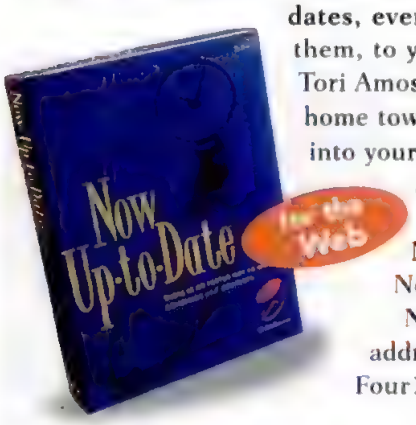

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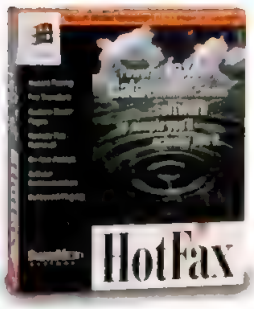

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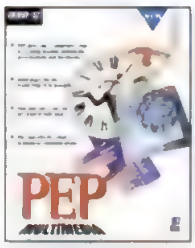

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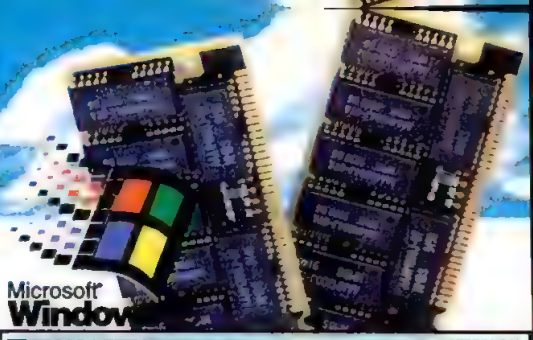

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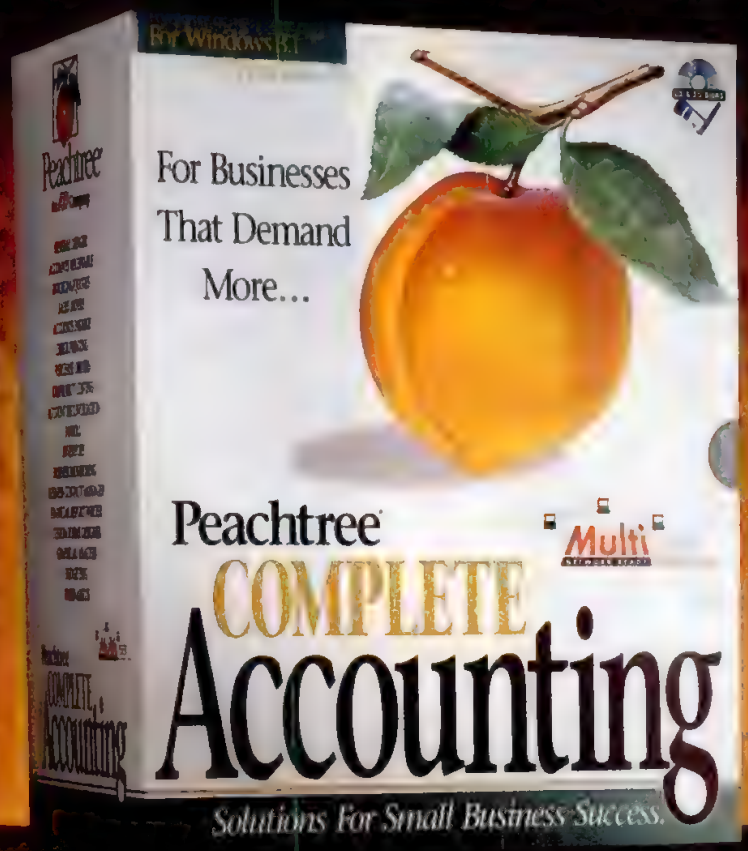

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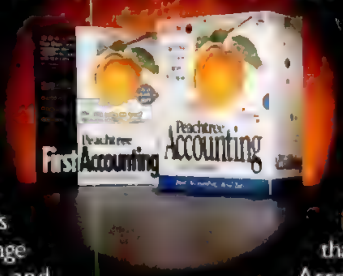

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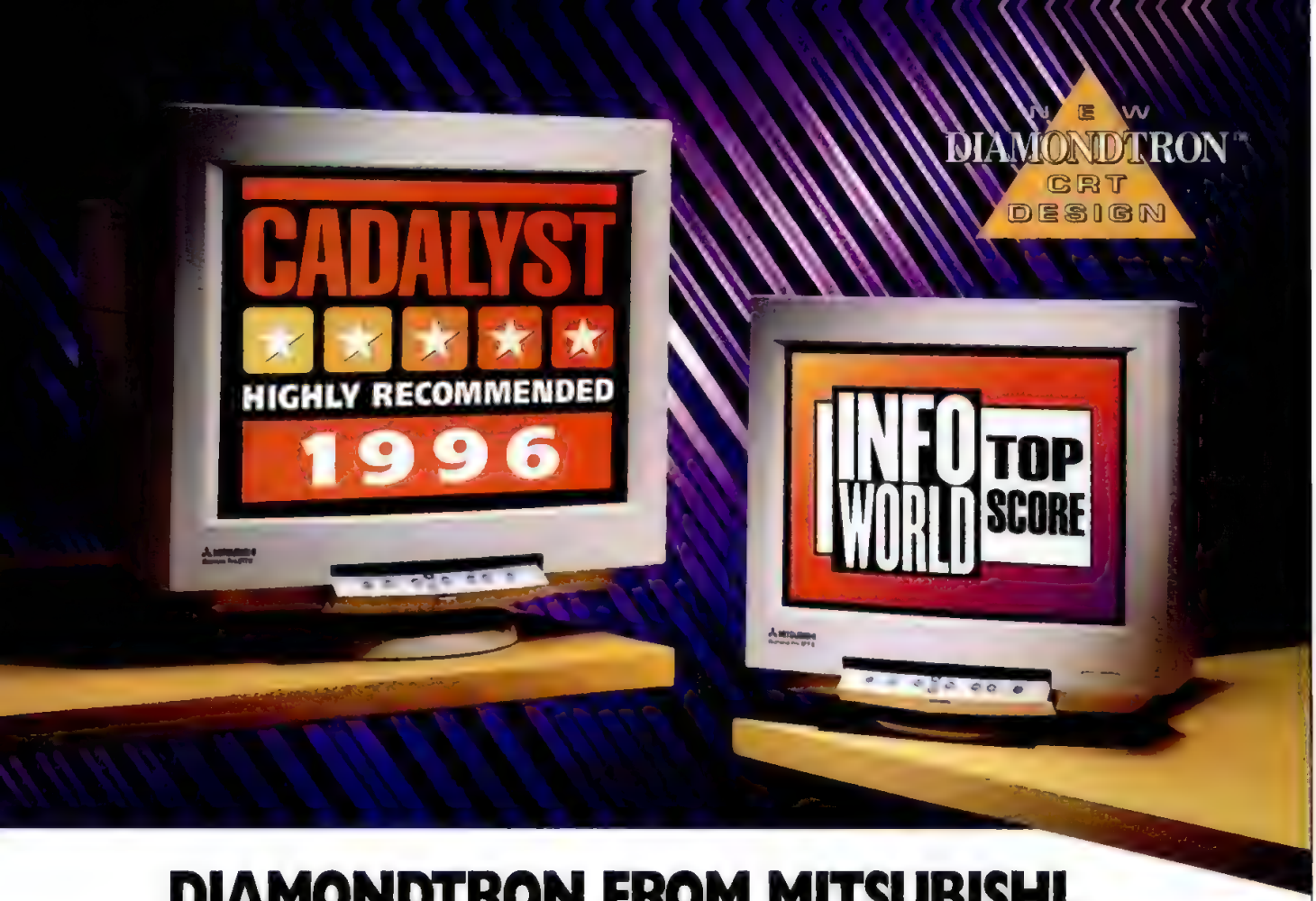

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Diamond Scan 15VX	15"/13.8" DVI*	1280 x 1024/60 Hz NI,	H:30-65 kHz, V:55-100 Hz	$410.00
Diamond Scan 17HX	17"/15.7" DVI*	1600 x 1200/65 Hz NI	H:30-82 kHz, V:50-130 Hz	$849.00
Diamond Scan 20H	20"/18.6" DVI*	1600 x 1200/65 Hz NI	H:30-82 kHz, V:50-152 Hz	$1,699.00
Diamond Scan 20M	20"/18.6" DVI*	1024 x 768 I, 800 x 600 NI	H:15-38 kHz, V:45-90 Hz	$1,699.00
Diamond Scan 20LP	20"/18.6" DVI*	1024 x 768 I, 800 x 600 NI	H:15-38 kHz, V:45-90 Hz	$1,745.00
Professional Line				
Diamond Pro 17TX	17"/16.0" DVI*	1600 x 1200/66 Hz NI	H:30-86 kHz, V:50-152 Hz	$1,059.00
Diamond Pro 21TX	21"/19.7" DVI*	1600 x 1200/75 Hz NI	H:30-93 kHz, V:50-152 Hz	$1,899.00

* DVI: Diagonal Viewable Image. Certain non-standard timing formats will reduce Diagonal Viewable Image.

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DISPLAY PRODUCTS

Diamond Pro 17TX

Diamond Scan 20H

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PC MAGAZINE EDITORS' CHOICE February 20, 1996

When it comes to Hurricane, the experts are unanimous:

PC Magazine raves: *"Hurricane whirls Windows performance to new heights"...."It is essential equipment for today's Windows PC."*[1] *"Nothing else came close to letting us load and run so many applications at once... hands-down the best package around."*[2] **Windows Magazine** is in awe: *"Hurricane is a veritable Houdini...the difference is dramatic...lets your system exceed its limitations."*[3] **PC World** is definitive: *"Hurricane provides the best performance."*[4] **The Christian Science Monitor** gushes: *"...There's a new star on the horizon. Hurricane allowed me to load 14 of my favorite programs at the same time."*[5] **Computer Shopper** gets to the bottom line: *"Hurricane offers the most bang for the buck."*[6]

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[1] 9/26/95 [2] 2/20/96 [3] 9/95 [4] 10/95 [5] 12/12/95 [6] 11/95

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CIRCLE 063 ON READER SERVICE CARD

tion structure's hProcess and hThread fields contain the new process's handle and the handle of its main thread. ExecInstall closes the hThread right away, since it isn't needed, and passes the handle and the ThdProcDone event handler to the constructor for the TProcDoneThread object. Figure 4 is the entire source code for TProcDoneThread. you'll surely find a use for this object in your own programs.

Delphi's TThread object is an abstract type; you never create an instance of TThread. Rather, you define a TThread descendant whose Create constructor performs any extra initialization and whose Execute method performs the desired action. This particular object's constructor passes False to the inherited constructor, meaning that the thread should be created in an active rather than suspended state. It stores the passed process handle in the private data field ProcHandle, sets its OnTerminate property to the event handler supplied by the calling process, and sets its FreeOnTerminate property to True.

The WaitForSingleObject API function's behavior depends on the type of handle it is passed. The Execute method passes a process handle, so the function waits until the process terminates. At that time, the Execute method closes the process handle it was using. Because the thread's FreeOnTerminate property is True, the thread object is released from memory as well. The OnTerminate event handler back in the main program is triggered, indicating that the process has ended.

InCtrl has grown quite a bit since its debut in 1993. By keeping up with changes in the underlying Windows platform, it retains its usefulness, and the changes required in the programming make for an interesting discussion. Perhaps the next version of Windows will have its own installation tracking built in. If not, InCtrl will be there to help! □

Neil J. Rubenking is technical editor of PC Magazine.

GUIDE TO OUR UTILITIES

ABOUT INCTRL 3...

DESCRIPTION InCtrl 3 lets you track system changes made by Windows 95 and Windows NT installation programs. Like InCtrl 2 for Windows 3.1, it tracks file additions and deletions as well as changes made to .INI files. In addition, it handles long filenames and tracks changes to the Registry. InCtrl3 is a 32-bit program and requires Windows 95 or Windows NT.

USAGE To install InCtrl 3, create a new directory and copy the files INCTRL3.EXE and INCTRL3.HLP to it. You may add INCTRL3.EXE to your Start menu, if you wish, or simply launch it from the Start menu's Run dialog as needed.

InCtrl 3 stores its own persistent data in the Registry. If you decide to remove it from your system, first issue the command

```
INCTRL3 CleanRegistry
```

either from a DOS box or from the Start menu's Run dialog. After doing this, you can simply delete InCtrl 3's directory and all the files it contains.

InCtrl 3 uses a wizard-style interface, so you don't have to remember how to use it between program installations. The first page introduces the program, and each succeeding page asks a simple question. Buttons marked Next and Prev let you navigate back and forth among the pages. The Next button is enabled only when the current question has been answered appropriately. When you've answered all the questions, click on the Finish button to perform the installation.

InCtrl 3 will shrink to a small, always-on-top window and begin recording preinstallation system data. Just so you'll know it's not idle, it keeps the small window updated with a report of what it's doing. If for some reason you decide not to go through with the installation, click on the Abort: No Install button. Once the install program has been launched, however, it can't be unlaunched; at that point, the button changes to Abort: No Report.

When the install program ends, InCtrl 3 will beep and present the message "Install may be complete." This means that the install program launched by InCtrl 3 has terminated. But since that program may have launched a secondary install program, InCtrl 3 can't be sure the entire process is done. You, the user, are the final arbiter. When you see that the installation is complete, press the Install Done: Report button. InCtrl 3 will gather its postinstall system information, generate a report of changes, and preview the report on the screen. The report file is a plain-text file that you can view or edit at any time.

Most of the on-screen elements have Windows 95–style pop-up help. To invoke pop-up help for a particular component, either click on it after clicking on the question-mark icon on the title bar or right-click on it and select "What's This?" from the menu.

SUPPORT Help for *PC Magazine*'s free utilities can be obtained electronically in the Utilities section of ZD Net's Tips forum (GO ZNT:TIPS). You may find an answer to your question simply by reading the messages posted in the forum. If the author is not available and the forum sysops can't answer your question, the Utilities column editor will contact the author for you.

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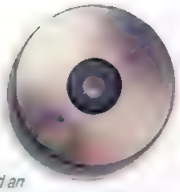

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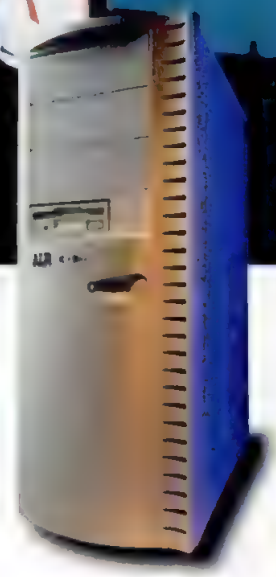

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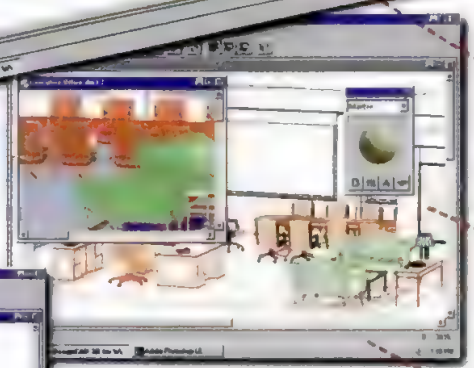

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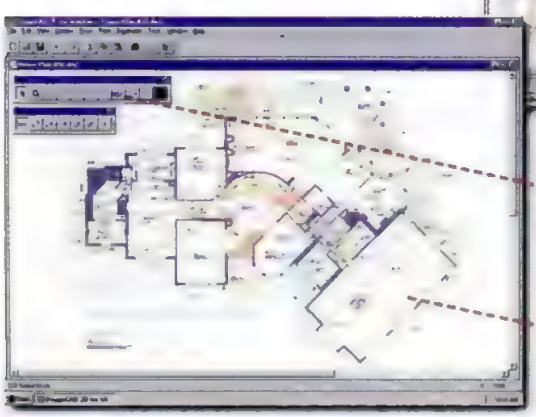

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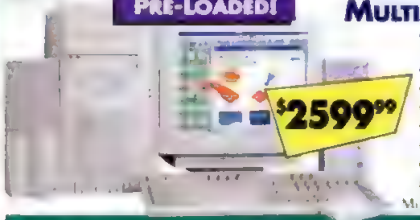

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User-to-User

By Neil J. Rubenking

Create Secure User Profiles with Windows 95's Policy Editor

Publicly accessible computers, such as those in schools, require a significant degree of security to prevent abuse. The Windows 95 CD-ROM provides the tool you need to implement restrictive policies on such machines in the form of the Policy Editor (POLEDIT) application (see Figure 1). Unfortunately, the Windows 95 Resource Kit doesn't tell you how to use POLEDIT for standalone computers, so I developed a method of my own:

- ***Prepare the System.*** *Use Explorer to make backup copies of USER.DAT and SYSTEM.DAT, in case of emergency. Make sure you have at least 10MB free on the Windows drive to hold user profile information.*
- ***Enable User Profiles.*** *Launch the Password applet in Control Panel. Click the User Profiles tab, click the option Users can customize..., and check the two check boxes. Click OK; Windows will restart.*
- ***Create Profiles.*** *When Windows restarts, log on as User and allow Windows to create folders to hold your profile information. Shut down and log on again as Administrator, with a suitably obscure password, and again allow Windows to create profile folders. Don't forget this password!*
- ***Restrict User Access to Programs.*** *While logged on as Administrator, use Explorer to navigate to C:\WINDOWS\PROFILES\USER\STARTMENU. In this folder and those below it, delete any shortcuts to programs the user shouldn't be allowed to run, including every shortcut in the Recent folder. Be sure to delete shortcuts to POLEDIT, Regedit, and Explorer.*
- ***Install Policy Editor.*** *Launch the Add/Remove Software applet in Control Panel, click the Windows Setup tab, and press the Have... button. Navigate to the ADMIN\APPTOOLS\POLEDIT folder of the Windows 95 CD-ROM and install POLEDIT.INF. This will install POLEDIT and put it on the Accessories\System Tools submenu of the Programs menu. It will also place the critical policy template file ADMIN.ADM in the C:\WINDOWS\INF directory. If you don't have the CD, you can download POLEDIT from* http://www.microsoft.com *or CIS MSWIN.*
- ***Define Default User Policy.*** *Launch POLEDIT, create a new file, and add new users named User and Administrator. Double-click the Default User icon, select System | Restrictions, and check all four boxes. Select Shell | Restrictions and check the four boxes whose captions begin with Remove, plus the two that say Hide All Items on Desktop and Don't Save Setting at Exit. Do not check the Disable Shut Down command. Use Explorer to create a folder named C:\WINDOWS\PROFILES\DUMMY. Back in POLEDIT, select Shell | Custom Folders and check all the boxes, filling in the dummy folder name you just created for those that require paths. Click OK and save the file as CONFIG.POL.*
- ***Define User Policy.*** *Load the example policy file MAXIMUM.POL, click on the Default User icon, and choose Copy from the Edit menu. Reload CONFIG.POL, click on the User icon, and select Paste from the Edit menu. Double-click the User icon and choose Shell | Custom Folders. Click on the text of each check box in turn and, if an edit*

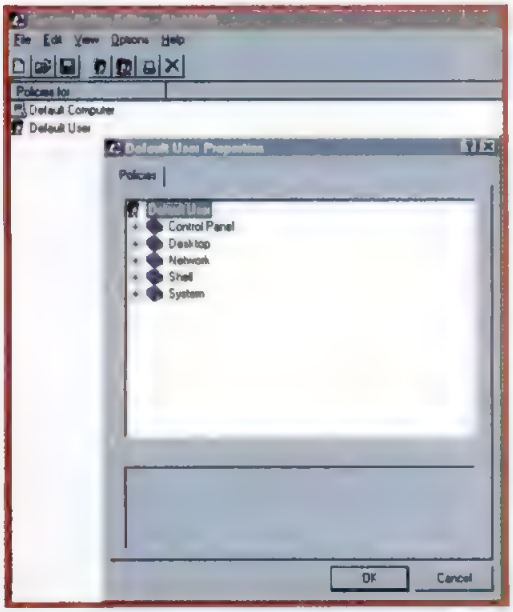

FIGURE 1: *The Windows 95 Policy Editor lets you limit access to a system.*

HIGHLIGHTS

HARDWARE Most PCs are set up for just two floppy disk drives, but it is possible to connect three or four to a single system. *Page 362*

SPREADSHEETS Date values can be used in Excel formulas, but only if you let the program know that 03/15/96 doesn't mean 3 divided by 15 divided by 96. *Page 372*

DATABASES Here's a third party tool that changes all forms, reports, and modules that reference the column when you rename it. *Page 376*

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box appears below, replace C:\WINDOWS with C:\WINDOWS\PROFILES\USER. Make sure all boxes remain checked. Select Control Panel | Passwords and check the Restrict box; then check the other four boxes that appear below. Under Shell | Restrictions, check Remove Run command, Remove Find command, Hide Drives in My Computer, and Don't Save Settings at Exit. Consult the Windows Resource Kit Help to determine what other restrictions you may wish to add, but be sure not to check Disable Shut Down command. Now go to the Shell | Restrictions and System | Restrictions and change any gray check boxes to blank.

• ***Define Administrator Policy.*** *Double-click the Administrator icon and go through the entire list of restrictions, setting every check box to blank, not gray. This protects the Administrator policy from being affected by the Default User policy.*

• ***Define "no user" Policy.*** *Log on again, but press Esc to close the log-on prompt. Run POLEDIT, select Open Registry from the File menu, and double-click Local User. Apply all the same restrictions you applied to Default User. Then log on as Administrator again.*

• ***Enable Policy Loading.*** *Load CONFIG.POL in POLEDIT, open the Default Computer icon, select System, and check Enable User Profiles. Under Network\Update, check Remote Update. Select Manual for the Update Mode, and enter C:\WINDOWS\CONFIG.POL as your path. Save CONFIG.POL. Now select Open Registry from the File menu, double-click Local Computer, and make the same change to the network update mode. Save changes and exit POLEDIT.*

• ***Test Policies.*** *Log on as User; check to see that the policy restrictions you specified are in place. Log on as Administrator and check that there are no restrictions. Now shut down and log on again, but use a new name and password. There should be no icons on the desktop and no programs available from the Start Menu (nothing to do but log on again). This time press Esc at the log-on prompt to bypass entering a user name. Again you should have no option but to shut down and log on again.*

• ***Protect Policies.*** *Log on as User and confirm that there is no way to run POLEDIT. For greater safety, change the file named ADMIN.ADM (in the C:\WINDOWS\INF folder) to something else. Use the DOS command ATTRIB to remove the read-only, hidden, and system attributes from the file C:\MSDOS.SYS, and load it into your favorite editor. Find the heading [Options] and change the Bootkeys= key to Bootkeys=0. If this key is not present under [Options], simply add it. Save the file and restore its read-only, hidden, and system attributes. This change prevents the user from breaking out of Windows 95's startup process. Finally, if the system BIOS permits, use its SETUP program to disable booting from a floppy disk.*

RICHARD TURNER, *Augusta, Georgia*

PC MAGAZINE: This may be one of the longest User-to-User letters we've ever published, but I think you'll agree that it's unusually valuable. Follow the steps here to give your system the maximum protection available in Windows 95 systems. Do note that each attempt by a user to log on with a new name will create a folder below C:\WINDOWS\PROFILES containing a copy of USER.DAT. You'll want to periodically delete all such folders except User, Administrator, and dummy.

If the MAXIMUM.POL and STANDARD.POL files mentioned here are not on your hard disk, look in the folder \ADMIN\RESKIT\SAMPLES\POLICIES on the Windows 95 CD-ROM. For help on the meaning of various policy restrictions, launch WIN95RK.HLP in the \Admin\Reskit\Helpfile folder.

Quick Disk Space Report in DOS 7

I've discovered a neat tip you can use in any DOS 7 box under Windows 95. If you want to see how much disk space is used or how much is still free and don't want to run CHKDSK on a huge hard disk to find out, you can use the following command:

```
DIR SDF /V
```

The first parameter can be any nonexistent filename. The /V is the Verbose option; it gives extended information about the files and subdirectories. So the command is telling DOS to show any files with that name, along with the extended information. Since there are no files with that name, you'll simply see the bytes free, total disk space, and percent in use, as Figure 1 shows. It bypasses all the directories and files and skips right to the desired information.

BEN WATSON, *VIA ZD NET*

PC MAGAZINE: The /V parameter is new in DOS 7, and its extended information can be quite useful, as Figure 2 shows. The File Name, Size, and Modified columns correspond to the first three columns of a regular DIR listing, and the long filename appears on the following line. The Allocated column gives the file's size rounded up to the nearest whole cluster, which is the actual amount of disk space that the file uses. The Attrib column lists each file's attributes. And the Accessed column reports when the file was last accessed. Of course, the disk space report at the bottom is present as well. If you haven't tried the DIR command's /V parameter, give it a whirl now.

```
Volume in drive D is 1600MB-DATA
 Volume Serial Number is 256C-16F6
 Directory of D:\

File not found
                    487,587,840 bytes free
                1,622,343,680 bytes total disk space,  69% in use
```

FIGURE 2: *You can use the DIR /V command in DOS 7 to obtain a quick report on used and free disk space.*

```
Volume in drive C is WINDOWS 3_1
 Volume Serial Number is 1E71-14FF
 Directory of C:\bat
File Name        Size       Allocated      Modified      Accessed  Attrib


.              <DIR>                     11-19-95  7:17a 11-19-95      D
.
..             <DIR>                     11-19-95  7:17a 11-19-95      D
..
SNAPYO~1 BAT          488         8,192  03-05-96 10:01a 03-05-96      A
Snap your fingers and cha-cha-cha.bat
CHOPPI~1 BAT          797         8,192  03-05-96 10:05a 03-05-96      A
Chopping water, carrying wood.bat
        2 file(s)          1,285 bytes
        2 dir(s)          16,384 bytes allocated
                      46,817,280 bytes free
                     133,308,416 bytes total disk space,  64% in use
```

FIGURE 3: *Use the /V switch with DOS 7's DIR command for a verbose listing of file information.*

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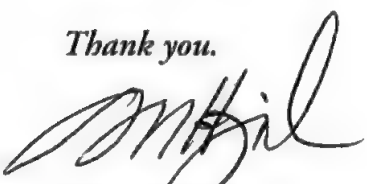

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I have a 486-based system with four front-accessible drive bays. Is it possible to install three floppy disk drives—two 3.5-inch and one 5.25-inch—or do I need to purchase an external enclosure? If I can install three, how do I configure them? My system BIOS has places for only two drives. What drive letter would the third floppy get?

JUSTIN GRANT, *Phoenix, Arizona*

PC MAGAZINE: Just as we may never see the "paperless office," it also looks like we won't be seeing "floppyless" computers any time soon. While it's true that most systems are set up for just two floppy disk drives, it is certainly possible to install three or four drives.

The component you need is a controller designed to handle more than two floppy drives. There are a number of manufacturers of such devices, including GSI (800-486-7800, 714-261-7949).

The GSI boards use an on-board BIOS for the floppy connections, so no system memory is used up by software drivers. The company's Model 11 board has two headers, each of which can take a typical two-connector floppy cable. The board's configuration software lets you choose the drive assignments for the attached floppy drives: A, B, "3," and "4." The last two will be given drive letters by DOS during the boot process, and will be assigned letters after all the partitions on all hard disks, but before any drives such as CD-ROM drives that rely on software drivers.

One warning: According to a GSI representative, Windows 95 does not recognize more than two floppy disk drives on the company's boards. If you want to use such a board with Windows 95, be sure to check out the compatibility issues before you buy.—*Alfred Poor*

Beyond BASIC Black

I recently upgraded to an Epson Stylus color ink jet printer, and I want to write QuickBasic code that will print text in color on my new printer. I used the "COLOR x" command followed by LPRINT, but the output only prints in black and white. What do I need to do?

JAMES C. ALLEN, *Aptos, California*

PC MAGAZINE: The problem is that you haven't been sending the color commands to the correct device. The QuickBasic COLOR command affects the screen display, but has no effect on the printer. What you need to do is send specific commands to the printer to tell it which color to use. Most printer commands begin with the Escape character (ASCII 27), which signals the printer to treat the data that follows as a command and not as something to be printed. For this reason, people often refer to printer commands as "Escape sequences."

Different printers use different commands. The Epson Stylus printers use a variation of the Epson 24-pin dot matrix command language, and the Escape sequence for color output is ESCAPE "r"*n* where *n* is one of the following ASCII values:

```
0 Black
1 Magenta
2 Cyan
3 Violet
4 Yellow
5 Orange
6 Green
```

To send this command to your printer, you can use the ASCII code CHR$(27) with the

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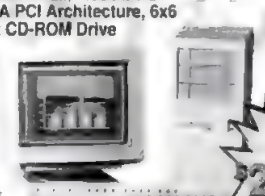

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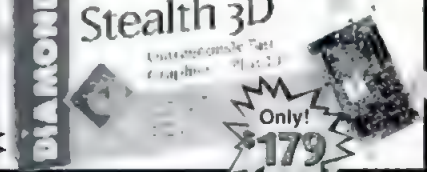

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CIRCLE 010 ON READER SERVICE CARD

LPRINT command. For example, to print a line of green text, you could use the following QuickBasic line:

```
LPRINT CHR$(27) "r" CHR$(6); "This is
➥a line of green text."
```

You could also use the ASCII value CHR$(114) in place of the "r" in the command line if you prefer.

Other color printers use different command sequences to set the color of the print. For example, PCL color printers have a much more complex system that lets you define custom color palettes. The Escape sequence information may not be included in your printer's manuals; you may need to contact the manufacturer and purchase a technical reference to get all the details for your particular printer.—*Alfred Poor*

Partition Puzzle

My new computer came with its 1.6GB hard disk configured as a single partition, but I want to set it up as multiple 255MB partitions to keep the cluster size small. If I repartition the disk, however, I worry that I will lose all of the preinstalled software. The company from which I bought the system provided Windows 95 and the other software on CD-ROMs, but I don't see how I'll be able to reboot the system from a CD-ROM if I wipe out the operating system when I repartition. Is there any way to boot from a CD-ROM drive?

NORM PETERSON,
Santa Monica, California

PC MAGAZINE: Vendors usually create only a single partition on huge hard disks, probably because there's no profit in creating custom configurations for each individual user. And since the growing user base tends to be less technologically knowledgeable nowadays, support for custom configurations could be a nightmare. The fact is, though, that a single large partition is not an efficient use of disk space, so it makes sense to repartition your hard disk. (For a discussion of why a single, large partition is inefficient, see the May 14, 1996, Solutions column.)

Unfortunately, the simple answer to your question is that you can't boot from a CD-ROM drive. Luckily, it's easy enough to create a floppy disk to take care of the problem—and this is a procedure that all Windows 95 users will want to follow if they haven't already done so.

First, create your boot disk. You'll need a floppy disk with at least a 1.2MB capacity. (Any data that is on the floppy will be erased in this process.) Go to the Windows 95 Control Panel and choose the Add/Remove Programs applet. The third tab on the top of this window reads "Startup Disk"; this will create an emergency boot disk that you can use for your system. Note that you'll need to insert the Windows 95 CD-ROM in your system when you create this disk, so make sure it's handy before you start.

This procedure creates a disk you can use whenever you need to boot your system. All Windows 95 users should have such an emergency start-up disk for each system, and you must remember to create a new one whenever you add new hardware to your system.

> All Windows 95 users should have an emergency start-up disk, and you must remember to create a new one whenever you add new hardware to your system.

Your start-up disk will also contain the FDISK, FORMAT, and SYS utilities you'll need to partition and format your hard disk. Then you'll have to reinstall all of your software (or restore it from a backup, if you've made one).

If you're willing to spend a little money for some peace of mind, the $49.95 PartitionMagic 2.0 utility from PowerQuest (800-379-2566) will repartition your disk nondestructively. With this product, you can shrink existing partitions without harming the data, create new partitions from the space thus freed, and also nondestructively reduce the cluster size of the now-smaller partition. This is a lot less nerve-racking than using FDISK, which destroys the contents of your disk when it changes the partitioning.—*Alfred Poor*

OPERATING ENVIRONMENTS

When Windows 95 Won't Start . . .

Help! Today I tried to change video drivers. I chose what I thought were the correct drivers, restarted Windows 95, and—nothing! I can no longer see the desktop.

I had already set up the machine to boot to the command prompt, but Windows 95 doesn't seem to have a DOS-level setup like Windows 3.1. So I got out the 13 Windows 95 installation disks and reloaded the operating system. Unfortunately, setup didn't change the drivers, even though I was careful to select the known good drivers in the dialog box. Is there anything I can do to restore my original setup?

RICHARD L. TURNER, *via ZD Net*

PC MAGAZINE: Don't worry; there's an easy solution! Restart your system, and when you see "Starting Windows 95..." on the screen, press F8 to get the Windows 95 startup menu. Select Safe mode from this menu. Because you're set up to start at the command prompt, you'll have to enter WIN to start the Windows 95 graphical user interface. In Safe mode, Windows 95 uses a standard VGA driver and the bare minimum of device drivers. Now you can change the video-driver settings from within Windows 95. Safe mode exists to remedy precisely the kind of situation you've encountered: a driver problem that prevents you from running Windows 95.
—*Neil J. Rubenking*

Warping Your Pentium for Optimum Performance

I upgraded my system processor from a 486/33 to a 90-MHz Pentium. It runs faster, but not as much as I'd expected. In particular, when multitasking, it seems as though background tasks don't run much faster than they did before the upgrade. Is there a problem with Warp on Pentiums?

JOHN SMITH, *New York, New York*

PC MAGAZINE: No, there isn't a problem, but you should keep in mind some assumptions that were made in the development of OS/2 Warp. When Warp first came out, the emphasis was that OS/2 could now run reasonably well on lower-end systems, all the way down to 486/25 machines with 4MB of RAM. In order to do that, the default configuration for Warp was one that would provide acceptable performance in that environment.

Now that you have upgraded, however, the default configuration is no longer the best for your needs. We could easily do a feature story on performance tuning, but here are two quick adjustments that should help a lot: In your CONFIG.SYS file, locate the line that says MAXWAIT=3. This line tells OS/2 that a task can wait a maximum of 3 seconds for access to the processor before its priority is raised to make it more likely to gain control. A 486/33 can only do so much each second, so the parameter is set for 3 seconds, allowing the processor to spend that time doing actual work, not just switching back and forth between tasks.

Your new Pentium/90, however, can do a lot more in each second. As a result, you will likely find that performance is improved by dropping that value to MAXWAIT=1. To demonstrate the results, I created a short REXX program that keeps the processor in a tight floating-point multiplication loop. I started a 25MB file copy in the background

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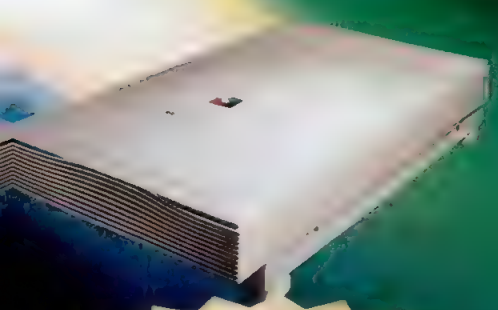

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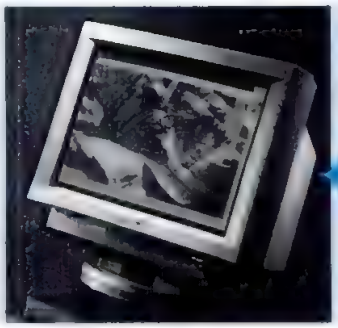

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CIRCLE 045 ON READER SERVICE CARD

and ran the REXX program in the foreground of a Pentium/90 system. With MAXWAIT set to 3, the file copy took a whopping 15 minutes 48 seconds to complete. After changing the MAXWAIT parameter to 1 (and rebooting the system), the same operation took only 3 minutes 21 seconds.

The second suggestion involves the TIMESLICE parameter. In OS/2 Warp, this parameter was removed from the default CONFIG.SYS. The TIMESLICE line controls the minimum amount of time each thread must get before it can be switched out for another task, and the maximum amount of time a thread can get before another thread of the same priority gets control. In Warp, leaving this out means OS/2 is allowed to adjust the parameter dynamically based on the job mix. That's probably best in many situations, but it may not be best for your particular job mix. In my example (admittedly contrived for extremity), inserting the line TIMESLICE=33,59 into CONFIG.SYS, rebooting, and rerunning the copy/math scenario dropped my copy time to only 1 minute 56 seconds.

Your mileage may vary, but you'll find that creative tuning can make a big difference in system performance when running OS/2 Warp.—*Brian Proffit*

WORD PROCESSING

Sequential Numbering For Nonconsecutive Paragraphs in Word

Is there any way in Word to number nonconsecutive paragraphs automatically at just one level for the numbering? I know you can use heading styles and add numbers to the headings by using the Format | Heading Numbering command, but that method adds numbering to every level of heading style in the document, not just to the level I want numbered. It also restarts the numbering for any level below Heading 1 whenever you use a higher level. I'm looking for a way to add numbers to just one level—that's not the Heading 1 level—while not restarting the numbering at any point.

JERRY PUGLIA, *Miami, Florida*

PC MAGAZINE: You're on the right track in thinking about using Heading styles for the kind of numbering you want. The trick is to realize that you don't have to use Heading 1 styles for first-level headings, or even use Heading styles for headings at all.

Both Word 6.0 and Word 7.0 let you define the heading numbering format for each level separately. One of the choices for the number format, none, removes numbers from that level entirely. So, one way to get the sequential numbering you want is to redefine Heading 2 through Heading 9 to eliminate numbers. You can then use Heading 2 as though it were Heading 1, Heading 3 as though it were Heading 2, and so on, reserving the Heading 1 style for the paragraphs you want sequentially numbered. You'll lose the ability to use Word's built-in Outline feature to organize your document, but for most documents, that shouldn't matter.

To define the number formats, choose Format | Heading Numbering, then choose Modify to open the Modify Heading Numbering dialog box. First, use the choices in the Number Format box to set the format for Level 1, which is the Heading 1 style. Next, go to the Level box just below the Help button in Word 6.0, or below the Cancel button in Word 7.0, and use the slider bar to move to Level 2, which defines the format for the Heading 2 style.

You can now go back to the Number Format box and remove all numbering from Level 2. Set the Bullet Or Number box to {none}, make sure there's nothing in the Text Before or Text After boxes, and check that Include From Previous Level is set to Nothing. Repeat this procedure for all the other levels you plan to use in the document, and choose OK when you're done.

Since Word returns to its default numbering scheme for headings each time you open the Heading Numbering dialog box, you may want to record this entire procedure in a macro. To record the procedure, choose Tools | Macro, enter an appropriate name in the Macro Name text box, choose Record, then OK, and then follow the procedure for removing the numbers from Levels 2 through 9. When you're done, choose Tools | Macro, then Stop Recording, and choose File | Save All to save the changed NORMAL.DOT file with the new macro. You can then run the macro at any time to remove the numbers from Heading 2 through Heading 9 in any document.

Another way to get the same effect is to create a set of alternate heading styles named, say, Head 1 though Head 9. Store these in your NORMAL.DOT template, and you can use the Head 1 through Head 9 styles for headings, use the Heading 1 style for numbered paragraphs, and ignore the Heading 2 through Heading 9 styles entirely. The advantage to this approach is that you won't have to remove the numbering from Heading 2 through Heading 9, since you won't be using those styles.

Note too that with either approach, you can use the Heading 1 style to number any kind of paragraphs you like, not just headings. This can be handy if you number paragraphs the way lawyers sometimes do, with several individual paragraphs making up a single numbered "paragraph." To make this work, you only need to redefine the format for the Heading 1 style so that it matches the format for the rest of your text.

—*M. David Stone*

SPREADSHEETS

Getting Excel To Recognize Dates In a Formula

I have an Excel table that lists transactions by date entered, due date, and amount. Following these three columns are four others labeled Q1, Q2, Q3, and Q4 (see Figure 1). I want to write a formula in each of these columns that will generate either 0 or the value in the amount column, depending on which quarter the due date falls in.

In the Q1 column, I entered:

```
=IF(1/1/96<=B2<=3/31/96,C2,0)
```

This seems as though it should work, but it always gives me 0, even if the date in A2 lies between 1/1/96 and 3/31/96. So I then tried

```
=IF(B2>=35065,IF(B2<=35155,C2,0),0)
```

which works but is a pain in the neck. Do I really need to figure out the serial date values for my quarter boundaries and then write a nested IF formula? Isn't Excel smart enough to do some of this for me?

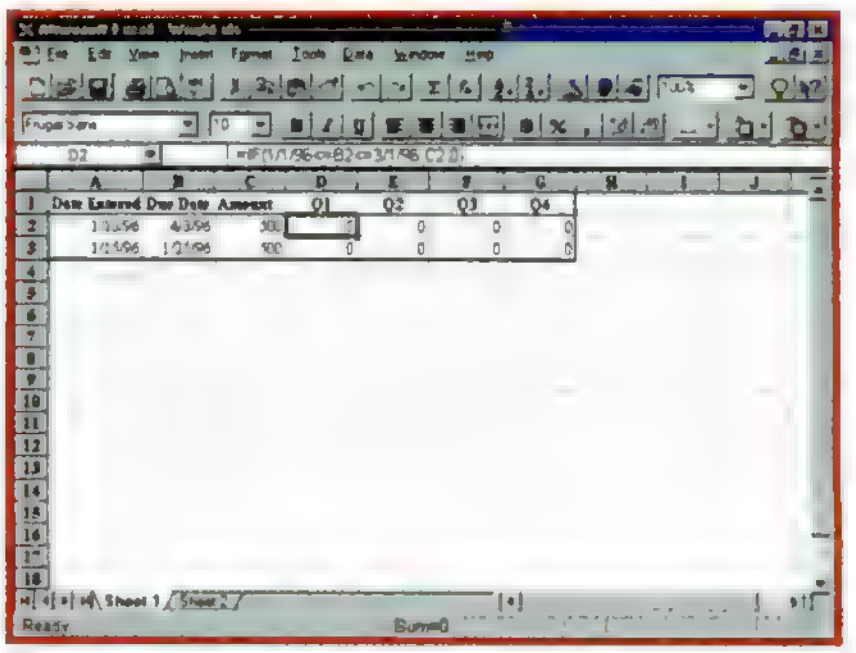

FIGURE 1: *When you put an expression like "1/1/96" in the middle of a formula, Excel can't tell whether you're thinking about the calendar or planning to divide some numbers.*

DAN WRIGHT, *Mukilteo, Washington*

PC MAGAZINE: Your original formula has two problems. First, Excel needs some help interpreting the date value. If you type 1/1/96 as a

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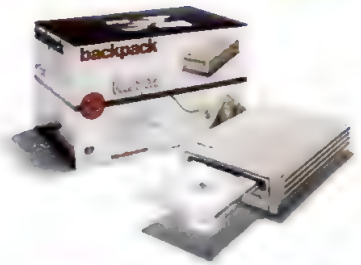

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constant in a cell (that is, if you don't put an equal sign in front of it), Excel knows you're entering a date. Internally, that date is represented by its serial date value, but in the cell, you see it formatted to look like a date (unless you change the format, of course). When you put that same expression in the middle of a formula, however, Excel no longer knows for sure that you're thinking about the calendar. It has to consider the possibility that you really mean to divide 1 by 1, and then divide that result by 96. So, you can't just write =IF(1/1/96<=B2...) if you want to compare B2 with January 1, 1996.

One way to make Excel recognize 1/1/96 as a date is the one you employed in your second formula: Determine the serial date value and use that number instead of the date expression. To avoid the hassle of getting the date value yourself, you can use Excel's DATEVALUE function. The function requires a text argument, so you use it like this:

```
DATEVALUE("1/1/96")
```

If you don't want to clutter up your IF formula with DATEVALUE functions, you can put the quarter boundaries in separate cells and then reference those cells. If you type 1/1/96 in cell A10, for example, then the expression =IF(A10<=B2...) will work fine, even though =IF(1/1/96<=B2...) would not.

That takes care of the first problem. The second problem is that you want Excel to evaluate two conditions: Whether the date is greater than or equal to January 1, and whether it is also less than or equal to March 31. Trying to do that by writing

```
=IF(DATEVALUE("1/1/96")<=B2<=DATEVALUE
➥("3/31/96"),C2,0)
```

is legal, but it won't take you where you want to go. Excel will compare the date value of 1/1/96 with cell B2, and that comparison will return either TRUE or FALSE. Then Excel will compare TRUE or FALSE with the date value of 3/31/96. In Excel's hierarchy of values, TRUE and FALSE are both greater than any number (don't ask why, that's just how it is), so the comparison will always prove false, no matter what's in A2.

One way to make Excel base an IF test on two or more conditions is to use the AND function. AND takes one or more arguments (up to 30 are allowed) and returns TRUE if all arguments evaluate to TRUE. Otherwise it returns FALSE.

```
=IF(AND(DATEVALUE("1/1/96")<=B2,
➥B2<=DATEVALUE("3/31/96")),C2,0)
```

should do the trick, returning C2 if B2 is a first-quarter date and 0 if not.—*Craig Stinson*

Scientific Misnotation From Excel to Word

Here's a Microsoft Office bug you might want to warn readers about: Microsoft Word 7.0 increases the value of any number entered in scientific notation in an Excel worksheet by one order of magnitude when the Insert File command is used in Word to insert the Excel spreadsheet into the Word document. Microsoft recommends you paste the Excel data via the Clipboard instead of using the Insert File command.

JIM POLISINI, *via the Internet*

PC MAGAZINE: Right you are, it's a genuine bug. The problem appears to lie on Word's side of the transaction. The same operation performed in other OLE containers works fine. I tested to see whether this bug also occurred when you're running Word 6.0 and Excel 5.0, and indeed it does.—*Craig Stinson*

DATABASES

Propagating Name Changes in Microsoft Access

Changing column names in a Microsoft Access database can be a real hassle if you've already created a lot of queries, forms, and reports. Is there an easy way to make bulk changes like this?

MARK ARONSON, *Taos, New Mexico*

PC MAGAZINE: You can use a third-party tool to accomplish this type of global search and replace operation, as I'll explain in a minute. You'll need one, because as you've discovered, Microsoft Access does not as of this writing propagate name changes or assist you in doing so yourself. This means that when you change a column name in a table, you have to manually make that change everywhere in your database—including all forms, reports, queries, macros, and modules that reference the column. To say the least, this can be a tiresome, error-prone process.

Fortunately, a third-party tool called SPEED Ferret (Figure 2) can help. SPEED Ferret lets you globally search for and replace a text string throughout your Access database, including all of the various database objects. You can even rename tables and queries. SPEED Ferret runs within Access as an Add-In accessible from the Tools menu.

Speed Ferret's user interface is simple enough. You supply the string you want to search for and the replacement value. Then you select whether to match only whole words or hits appearing anywhere in the text, and whether to make the search case-sensitive. You can also choose a pattern match, in which the text must match exactly, letter for letter. Finally you can choose to search the entire database or to restrict the search to selected objects only, based on object type (form, query, module, and so forth), name, owner, and modification date.

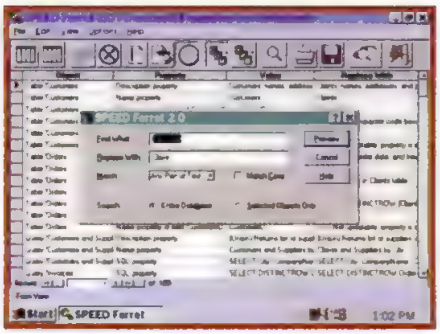

FIGURE 2: *Microsoft Access doesn't propagate name changes, but SPEED Ferret can help. This Access add-in lets you rename database objects and propagate name changes throughout an entire database.*

SPEED Ferret will locate every place where the search item is referenced and present the results in a datasheet Preview window. From there, you can sort and print the search results, edit the replacement values, delete rows so that the replacements do not occur, and otherwise examine the changes to be made. At this point, you'll want to review the changes carefully and make any adjustments. If you choose to save your replacements, SPEED Ferret automatically creates a backup so you can undo your changes later, should you desire.

SPEED Ferret helps automate an otherwise tricky and tiresome process. For more information, contact Black Moshannon Systems at 814-345-5657. Versions are available for both Access 95 and Access 2.0.—*Sal Ricciardi*

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4MB	410-12002	$89	16MB	410-12003	$269

Ready 425, 433

4MB	n/a	$89	16MB	n/a	$269

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4MB	OP-410-6205	$69	16MB	OP-410-6206	$279

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4MB	n/a	$59	8MB	n/a	$99
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Your 486 or Pentium computer should have at least 256k or cache memory for optimal performance!

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256k Cache Module $49

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256k Cache Module $69

AST

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		8MB	190597-001	$199
		16MB	190598-001	$459
Contura 4/25, 4/33		4MB	144790-001	$125
		8MB	144790-002	$289
		16MB	144790-003	$459
LTE Elite 4/40, 4/50, 4/75		4MB	199013-001	$125
		8MB	199015-001	$219
		16MB	199017-001	$449
Contura 400, 410, 420, 430		4MB	147653-001	$109
		8MB	147655-001	$219
		16MB	147657-001	$449
Elite 5000		8MB	213515-001	$289
		16MB	213515-002	$459
		32MB	213515-003	$859
		64MB	213515-004	$1,499

DELL

Model	MB	Part No.	Price
Latitude XP, P75, P90	8MB	3103435	$139
	16MB	3103436	$339

IBM

Model		MB	Part No.	Price
ThinkPad 360		4MB	84G5689	$89
		8MB	84G5692	$149
		16MB	84G5995	$339
ThinkPad 365, 365CD		4MB	92G7287	$99
		8MB	92G7293	$289
ThinkPad 701		4MB	04H6193	$109
		8MB	04H6194	$199
		16MB	04H6195	$349
ThinkPad 700, 720		4MB	07G1419	$109
		8MB	07G1420	$179
		16MB	07G1421	$389
ThinkPad 760, 760CD		8MB	92G7316	$349
		16MB	92G7316	$419
ThinkPad 760 E Series		8MB	92G7340	$299
		16MB	92G7341	$599
		32MB	92G7342	Call

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Model		MB	Part No.	Price
Versa S, Versa 2000, Versa 2200		4MB	OP-410-1207	$89
		8MB	OP-410-1202	$189
		12MB	OP-410-1203	$329
Versa V, M, P, 4000, 4050, 4080		4MB	OP-410-4001	$109
		8MB	OP-410-4002	$199
		16MB	OP-410-4003	$309
		32MB	OP-410-4004	$589
Versa 6000		8MB	OP-410-6201	Call
		16MB	OP-410-6202	Call
		32MB	OP-410-6203	Call

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		16MB	9803933-0001	$309
Extensa 550, 550CD, 560, 560CD, 570, 570CD		8MB	9809810-0001	$289
		16MB	9804841-0001	$389
		32MB	9809811-0001	$669
TM5000, 5010, 5030, 5100, 5200, TM 4000XM		8MB	979881-0001	$289
		16MB	979881-0002	$409
		64MB	9793357	$1,109

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		16MB	NW2028U	$339
		24MB	NW2029U	$389
T1900, T4600, T4700, T4800, T4850, T4900		4MB	PC-PA2012U	$109
		8MB	PC-PA2013U	$199
		16MB	PC-PA2014U	$339
T3400, T3600		4MB	PC-PA2019U	$80
		8MB	PC-PA2020U	$179
T400, T405, T410, T415, T610 Portege, T700, T705, Tecra 710, 720		16MB	PC-PA2023U	$309
		8MB	NW2033U	$199
		16MB	NW2032U	$329
Tecra 700		32MB	NW2034U	$559
		8MB	NW2035U	$259
		16MB	NW2036U	$499
		32MB	NW2037U	$909

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Model		MB	Part No.	Price
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		16MB	501488-003	$399
Ascentia 900N, 910N		8MB	501392-001	$99
		8MB	501392-002	$189
		16MB	501392-003	$469
Ascentia 950N		16MB	501728-002	$199
		16MB	501728-003	$399
Ascentia J		8MB	501984-001	$199
		16MB	501985-001	$399
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		8MB	FRJPC98MAB	$179
		16MB	FRJPC98MAC	$399

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HP LaserJet 5L					
1MB	C3939A	$50	2MB	C3147A	$79
4MB	C3148A	$99	8MB	n/a	$239
HP LaserJet IP, III, IIIP, IIID					
2MB	33475B	$79	4MB	33477B	$129
HP LaserJet II, IID					
2MB	33444B	$79	4MB	33445B	$129
HP LaserJet IIIsi, 4, 4M, 4Si, 4SiMX, 8000, Deskjet 1200c					
1MB	C2062A	$46	2MB	C2084A	$89
4MB	C2065A	$99	8MB	C2066A	$199
HP LaserJet 4P, 4MP, Color LaserJet					
2MB	C3131A	$50	4MB	C3132A	$85
HP Deskjet 500, 500C, 520, 520C, 550C, 560, 560C					
256K	22707B				$40
HP Deskjet 5P, 5MP					
4MB	C3132A	$55	8MB	C3133A	$289
HP LaserJet 5, 5N, 5M, 5Si, 5SiMX, 5+5M Color					
2MB	C3131A	$50	4MB	C3132A	$55
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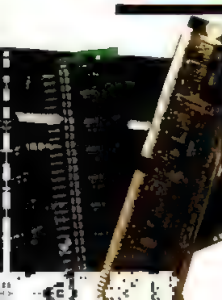

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CANON COLOR BUBBLEJET
BJC-70 — $287 — BJC-210 — $196
BJC-610 — $409 — BJC-4100 — $287

OKIDATA
OKIJET 2010 — $329 — OL600e — $395
OL610e — $488 — OL810e — $755

EPSON
Stylus Color IIs Inkjet — $207 — Stylus 1000 Inkjet — $473
Stylus Color II Inkjet — $282 — Stylus Color Pro Inkjet — $465
Stylus 1500 Inkjet — $878 — Stylus Color Pro XL Inkjet — $1,094

TEXAS INSTRUMENTS
MicroLaser Pro/8 — $1,097 — MicroLaser Pro/12 — $1,288

HEWLETT-PACKARD
Deskjet 340 — $296 — Deskjet 600c — $251
Deskjet 660c — $283 — Deskjet 820cse — $390
Deskjet 680c — $313 — Deskjet 855cse — $484
Laserjet 5L/5Fs — $504 — Laserjet 5P — $874
Laserjet 5MP — $1,024 — Laserjet 5 — $1,284

SEIKO INSTRUMENTS
Smart Label Printer EZ-30 w/software — $149
Smart Label Printer Pro w/software — $251

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Sportster 14.4 data/fax Int/Ext — $93/$110
Sportster VI 14.4, voice Int/Ext — $93/$111
Sportster 28.8 Wkr Modem Int — $139
Sportster 28.8 Int/Ext — $164/$185
Sportster 28.8 Voice Int/Ext — $185/$213
Sportster VI 28.8 Int/Ext — $275/$304

ZYXEL (ISDN Fax/Modem)
Elite 2864 28.8 ext. v.34 upg to ndn — $427
Elite 2864-e/i ndn 128kbps 2-wire leased lnd — $541

PRACTICAL PERIPHERALS
PC144MC/MT 14.4 Int/Ext — $79/$91
PM28BMC/MT 28.8 Int/Ext — $169/$189

BOCA
On-Line Express 14.4 Int/Ext — $55/$79
Boca Modem 14.4 Int /Ext — $79/$99
Multimedia Voice Modem Int — $89
Office Communicator V.34 Int — $219
Sound Expression 14.4 Int — $197
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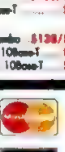

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Portégé 610CT

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- Lithium Ion battery technology
- Integrated Accupoint for easy control

Processor	Screen	RAM/HD	Price
Pentium 90	9.5" True Color	8/720MB	$3139

Tecra 720

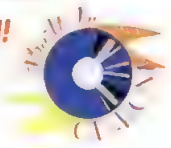
Tecra 720

BIG! 12.1" Display

- Pentium 133MHz processors
- PCI bus architecture (internal & external)
- 12.1", 1024 x 768 high resolution display
- Built-in 28.8 fax/modem with speaker phone
- Built-in 6X CD-ROM drive

Processor	Screen	RAM/HD	Price
Pentium 133	12.1" Active SVGA	16MB/1.2GB	$6299*

* Features built-in 6X CD-ROM drive



Tecra 700

BIG! 11.3" Display

- Pentium 120MHz processor
- PCI bus architecture (internal & external)
- 11.3", 800x600 high resolution display
- Built-in SoundBlaster compatible audio, speakers and microphone
- Indeo Runtime Video
- Optional 4X CD-ROM drive

Processor	Screen	RAM/HD	Price
Pentium 120	11.3" Dual Scan SVGA	8MB/1.13GB	$3999
Pentium 120	11.3" Active SVGA	16MB/1.13GB	4999

Tecra 700

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Satellite 100CS

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- Removable floppy drive

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan	8/504MB	$1969*

*Features EDO RAM memory

Satellite 100CS

Satellite Pro 410

- Built-in 4X CD-ROM drive (Active model only)
- Built-in 16-bit sound, microphone, speaker & MIDI
- EDO RAM memory expandable to 40MB
- Built-in V.34 adapter - small, sleek design & reduced weight
- Integrated Accupoint - small, accurate & easy to use
- Lithium Ion battery technology
- Built-in infrared for wireless communications

Processor	Screen	RAM/HD	Price
Pentium 90	11.3" Dual Scan SVGA	8/772MB	$3199
Pentium 90	11.3" Active SVGA	8/772MB	4399*

* Features built-in 4X CD-ROM drive

Satellite 410

digital™

Digital HiNote VP

Processor	Screen	RAM/HD	Price
Pentium 100	10.4" Dual Scan	8/810MB	$2399
Pentium 100	10.4" Active	8/810MB	2869*

*Includes 16-bit stereo sound, microphone & speaker

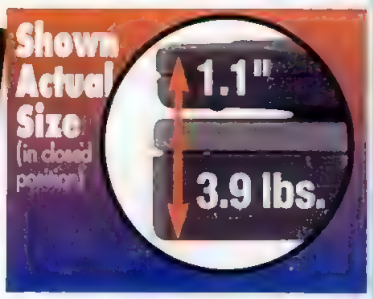
Digital HiNote Ultra II

- Up to 133MHz mobile Pentium processor
- 256KB of Level 2 cache
- 10.4" Active Matrix display
- 16mm trackball with sculpted palm rest

as low as $2999

Processor	Screen	RAM/HD	Price
Pentium 100	10.4" Active SVGA	8MB/1.08GB	$2999
Pentium 120	10.4" Active SVGA	8MB/1.08GB	3769
Pentium 133	10.4" Active SVGA	8MB/1.35GB	4059
Pentium 133	10.4" Active SVGA	8MB/1.35GB	4439

HiNote Ultra II shown with external floppy dock



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Pentium 100	12.1" Active SVGA	8/810MB	4499*
Pentium 120	11.3" Dual Scan	8/810MB	3599
Pentium 120	12.1" Active SVGA	8MB/1.08GB	4799
Pentium 133	12.1" Active SVGA	16MB/1.08GB	5499

* Includes built-in 4X CD-ROM drive

ThinkPad® 760E and 760ED

Processor	Screen	RAM/HD	Price
Pentium 120	12.1" Active SVGA	8/810MB	$4999
Pentium 120	12.1" Active SVGA	8MB/1.2GB	5199
Pentium 133	12.1" Active SVGA	16MB/1.08GB	5999
Pentium 133	12.1" Active SVGA	16MB/1.2GB	6999*

* Includes built-in 4X CD-ROM drive

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- Built-in sound card, speakers & microphone
- 256KB Level 2 cache
- Tilting keyboard with palm rest

Processor	Screen	RAM/HD	Price
Pentium 90	10.4" Active	8/810MB	$4249
Pentium 90	10.4" Active	8/810MB	4549*

* Includes built-in 4X CD-ROM drive
Windows 95 models also available

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ThinkPad® 760LD

TEXAS INSTRUMENTS

TravelMate Series

- Pentium 90, 120 & 133MHz processors
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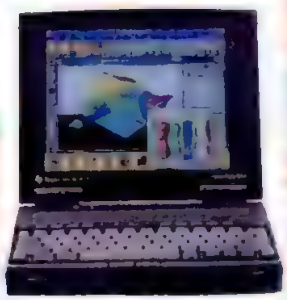
- Dual Lithium Ion batteries
- 32-bit PCI Local bus graphics
- 2MB video memory
- 256KB Level 2 cache
- 1280x1024 external monitor resolution
- 16-bit SoundBlaster compatible audio
- External PCI bus
- Windows 95 **AND** Windows for Workgroups

NEW MODEL!

UP TO 133MHz PENTIUM

Processor	Screen	RAM/HD	Price
Pentium 90	10.4" Active SVGA	8MB/1.2GB	$3419
Pentium 120	11.3" Active SVGA	8MB/1.2GB	4099
Pentium 133	11.3" Active SVGA	8MB/1.2GB	4699
Pentium 133	11.3" Active SVGA	16MB/2.1GB	5379

Ask about TravelMate 5270 & 5300 accessories promotion!



TravelMate Series
Product differs slightly from photo

Extensa 560/570 CD & CDT

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan	8/810MB	$2449*
Pentium 75	10.4" Active	8MB/1.2GB	3419*
Pentium 100	11.3" Dual Scan	8/810MB	2929†
Pentium 100	10.4" Active	8MB/1.2GB	3909†

* Includes built-in 4X CD-ROM drive
† Includes built-in 6X CD-ROM drive

Extensa 510

Processor	Screen	RAM/HD	Price
Pentium 90	10.4" Dual Scan	8/810MB	$2249

NEC

NEC Versa 2205

Processor	Screen	RAM/HD	Price
Pentium 75	9.5" Active	8/810MB	$2499

NEC Versa 550D

Processor	Screen	RAM/HD	Price
5x86/100	10.4" Dual Scan	8/540MB	$1699

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NEC Versa 4000

- Built-in 4X CD-ROM drive (selected models)
- Up to 120MHz Pentium processors
- 256KB Level 2 cache to optimize performance
- Unbelievable display – 65K color Dual Scan, 16.8 million color Active (High resolution 800x600 Active Matrix displays available)
- Built-in 16-bit sound, microphone, MIDI and 2 built-in speakers
- Multimedia docking station with outstanding Altec Lansing 4 speaker array (optional accessory priced separately)

Processor	Screen	RAM/HD	Price
Pentium 75	10.1" Active	8/810MB	$3799*
Pentium 90	10.4" High Res.	8/810MB	4099
Pentium 90	10.1" Active	8/810MB	4349*
Pentium 120	10.4" High Res.	8MB/1GB	4399

* Features built-in 4X CD-ROM drive

4X Speed

COMPAQ

Contura 430

- 10.4" Active & Dual Scan
- Fast 486DX4/100 processors
- Optical trackball – smoother and more reliable
- High capacity 720MB drives
- Compaq 3-year worldwide warranty

Processor	Screen	RAM/HD	Price
486DX4/100	10.4" Dual Scan	8/720MB	$2369
486DX4/100	10.4" Active	8/720MB	2869

LTE 5000 Series

on LTE 5000 optional accessory on other LTE 5000 models

- Up to 133MHz Pentium power with 256KB cache
- 32-bit PCI Local bus graphics
- 8MB or 16MB RAM exp. up to 72MB or 80MB (differs by model)
- Built-in 16-bit sound, microphone & 2 speakers
- MultiBay – holds CD-ROM, 2nd hard drive, floppy or 2nd battery
- Up to 1.35GB hard drives
- Built-in infrared for wireless communications
- Supports NiMH batteries
- Optional MPEG and TV video adapter

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan	8/510MB	$2830
Pentium 75	11.3" Dual Scan	8/810MB	3210
Pentium 75	10.4" Active	8/810MB	3589
Pentium 90	10.4" Active	8/810MB	3970
Pentium 90	10.4" Active	8/810MB	4340*
Pentium 120	10.4" Active	8MB/1.35GB	4720
Pentium 120	11.3" Active SVGA	16MB/1.35GB	5099
Pentium 133	12.1" Active SVGA	16MB/1.35GB	5669

* Features Built-in CD-ROM drive

LTE 5000

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- 11.3" Dual Scan & Active display with 800x600 resolution
- 800MB & 1.2GB removable hard drives
- Built-in SoundBlaster 16 Vibra chipset

Processor	Screen	RAM/HD	Price
Pentium 100	11.3" Dual Scan SVGA	8/800MB	$3299
Pentium 100	11.3" Dual Scan SVGA	8MB/1.2GB	3779
Pentium 133	11.3" Active SVGA	8/800MB	4249
Pentium 133	11.3" Active SVGA	8MB/1.2GB	4729

AST Ascentia J

- Integrated 14.4/14.4 data/fax modem and audio
- PCI bus architecture with 256KB Level 2 cache
- 10.4" SVGA (800x600) resolution Dual Scan and Active displays

Processor	Screen	RAM/HD	Price
Pentium 75	10.4" Dual Scan SVGA	8/500MB	$2149
Pentium 100	10.4" Dual Scan SVGA	8/800MB	2639
Pentium 100	10.4" Active Matrix SVGA	8/800MB	2839
Pentium 133	10.4" Active Matrix SVGA	8/800MB	3299

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- 32-bit PCI Local bus graphics
- Built-in 16-bit SoundBlaster compatible sound, microphone & 2 speakers (selected models)

Processor	Screen	RAM/HD	Price
Pentium 100	11.3" Dual Scan SVGA	8/515MB	$2199
Pentium 100	11.3" Dual Scan SVGA	16MB/1GB	2799*
Pentium 100	11.3" Dual Scan SVGA	8/MB/1GB	2999*††
Pentium 120	11.3" Active SVGA	8MB/1GB	3869*†
Pentium 120	11.3" Active SVGA	8MB/1GB	3999*††
Pentium 133	12.1" Active SVGA	16MB/1GB	5999*†

* Includes built-in sound system
† Includes built-in 4X CD-ROM drive
†† Includes built-in 6X CD-ROM drive

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HP OmniBook 5000

- Up to Pentium 120MHz with 32-bit PCI Local bus
- 1.2GB drives for high capacity storage
- Super VGA-800x600 resolution (selected models)
- Built-in 16-bit sound, microphone & speaker

Processor	Screen	RAM/HD	Price
Pentium 90	10.4" Active	8MB/1.2GB	$4449
Pentium 90	10.4" Active SVGA	16MB/1.2GB	4709
Pentium 120	10.4" Active SVGA	16MB/1.2GB	4939

HP OmniBook 5500

- Up to 133MHz Pentium with 32-bit PCI Local bus
- 10.4" or 12.1" Active Matrix display with 65,000 colors
- Super VGA-800x600 resolution on notebook
- PCI Local bus video, 1.5MB video memory
- 16-bit stereo sound with 2 speakers
- Optional 4X CD-ROM available

UP TO 133 MHz CPU, 1.5MB VRAM, 1.35GB HD

Processor	Screen	RAM/HD	Price
Pentium 120	10.4" Active	16MB/1.35GB	$5279
Pentium 120	11.3" Dual Scan SVGA	16MB/1.35GB	5279
Pentium 120	12.1" Active SVGA	16MB/1.35GB	5789
Pentium 133	12.1" Active SVGA	16MB/1.35GB	5999
Pentium 133	12.1" Active SVGA	16MB/2GB	6479

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2. Color kit
3. Rechargeable battery
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2. 60-page sheet feeder
3. Color Kit
$199.99

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HP LaserJet 5L printer (IBM, 4ppm, 600dpi) C3941A	$479.00
HP LaserJet 5P printer (IBM, 6ppm, 600dpi) C3150A	879.99

HP InkJet Printers

HP DeskJet 340 CV (bundle) C2664A	$309.99†
HP DeskJet 320 (bundle) C2637A#ABA	199.99†
HP DeskJet 600 printer C2184A	199.00
HP DeskJet 600C printer C4547A	259.00†
HP DeskJet 660C printer C2164A	299.00†
HP DeskJet 660Cse printer C4548A	309.00*†
HP DeskJet 682C C4567A#ABA	329.00†
HP DeskJet 820Cse printer C4568A#ABA	399.00†
HP DeskJet 855C printer C4551A	449.00†
HP DeskJet 855C e C4575A#ABA	499.00†
HP DeskJet 1600C printer C3540A	1349.99†

Home Office Products

HP OfficeJet LX C2891A	$599.99
HP FAX-700 C3530A	509.99

* Includes Family Font Package
† Includes HP Color Kit

Hewlett-Packard Scanners

HP ScanJet 4C scanner C2527B	$949.99
HP ScanJet 4S portable scanner C1127A	319.00
ScanJet 4P color scanner (C1137A#ABA)	499.00

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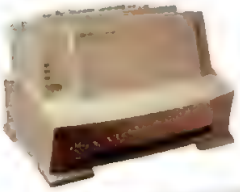
HP T1000 (internal) C4320RB	$169.00
HP T1000e (portable) C4326RB	219.99
HP SureStore, 2GB, DAT, Int C1525F	899.99
HP SureStore, 8GB, DAT, Ext C1529F	1220.00



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- 32-bit PCI controller for fast disk performance
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*4X CD-ROM on 7610

Processor	RAM/HD	CD-ROM	Price
Pentium 120	8MB/1.2GB	4X	$1799
Pentium 133	8MB/1.2GB	6X	2199
Pentium 150	8MB/1.2GB	6X	1999
Pentium 120	16MB/1.6GB	6X	2499
Pentium 133	16MB/1.6GB	6X	2299
Pentium 150	16MB/2GB	6X	2799
Pentium 166	16MB/2GB	6X	2999

Monitors priced separately

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- 64-Bit PCI Local bus graphics
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- Enhanced IDE interface-fast disk performance

Processor	RAM/HD	CD-ROM	Price
Pentium 100	16MB/1.2GB	6X	$1599
Pentium 133	16MB/1.2GB	6X	1799
Pentium 150	16MB/1.6GB	6X	2199
Pentium 100	16MB/1.2GB	6X	1699
Pentium 133	16MB/1.6GB	6X	2099
Pentium 150	16MB/2.1GB	6X†	2579
Pentium 166	16MB/2.1GB	6X†	2799

† with 3 disc CD changer

Monitors priced separately

AST Advantage Adventure

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Compaq ProLinea Desktops

- Blazing Pentium speed - up to 166MHz
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- PCI Local bus – high-speed graphics
- PCI IDE controller – fast disk performance
- Multiple chassis sizes – get the expansion you need
- Compaq, 3-year worldwide warranty with 1st year on-site

Processor	RAM/HD	Slot/Bay	Price
Pentium 75	8/630MB	3/3	$1329
Pentium 90	8/630MB	4/4	1549
Pentium 100	8MB/1GB	3/3	1569
Pentium 120	16MB/1.2GB	4/4	2199
Pentium 133	16MB/1GB	5/5	2299
Pentium 133	16MB/2GB	5/5	2539
Pentium 150	16MB/2GB	5/5	3299
Pentium 166	16MB/2GB	5/5	3529

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Processor	RAM/HD	Slot/Bay	Price
Pentium 100	16MB/1.2GB	3/3	$2099
Pentium 100	16/850MB	5/5	2013
Pentium 133	16MB/1.2GB	5/5	2243
Pentium 166	16MB/1.2GB	5/5	3019

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IBM PC 300

Monitors priced separately

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AST Bravo Series Desktops

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- 256K Level 2 cache
- Windows for Workgroups OR Windows 95
- Integrated 16-bit SoundBlaster audio on Bravo MS models
- Bravo MS models available in desktop **AND** minitower configurations

Processor	RAM/HD	Slot/Bay	Price
Pentium 100	8/630MB	5/4	$1199
Pentium 133	8/630MB	5/4	1339
Pentium 100	16MB/1.2GB	5/4	1429
Pentium 133	16MB/1.2GB	5/4	1559
Pentium 100	16MB/2GB	3/6	1879 *
Pentium 133	16MB/2GB	7/6	1989 *
Pentium 166	16MB/1.2GB	7/6	2219 *
Pentium 166	16MB/2GB	7/6	2449 *†

* Features 16-bit, integrated audio
† Features 6X CD-ROM drive

Monitors priced separately

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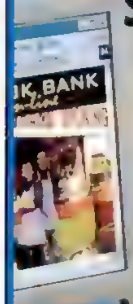

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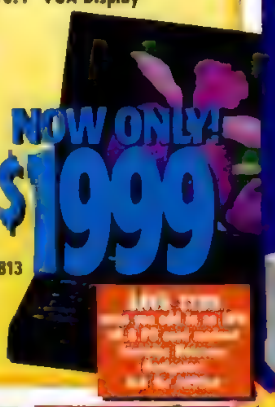

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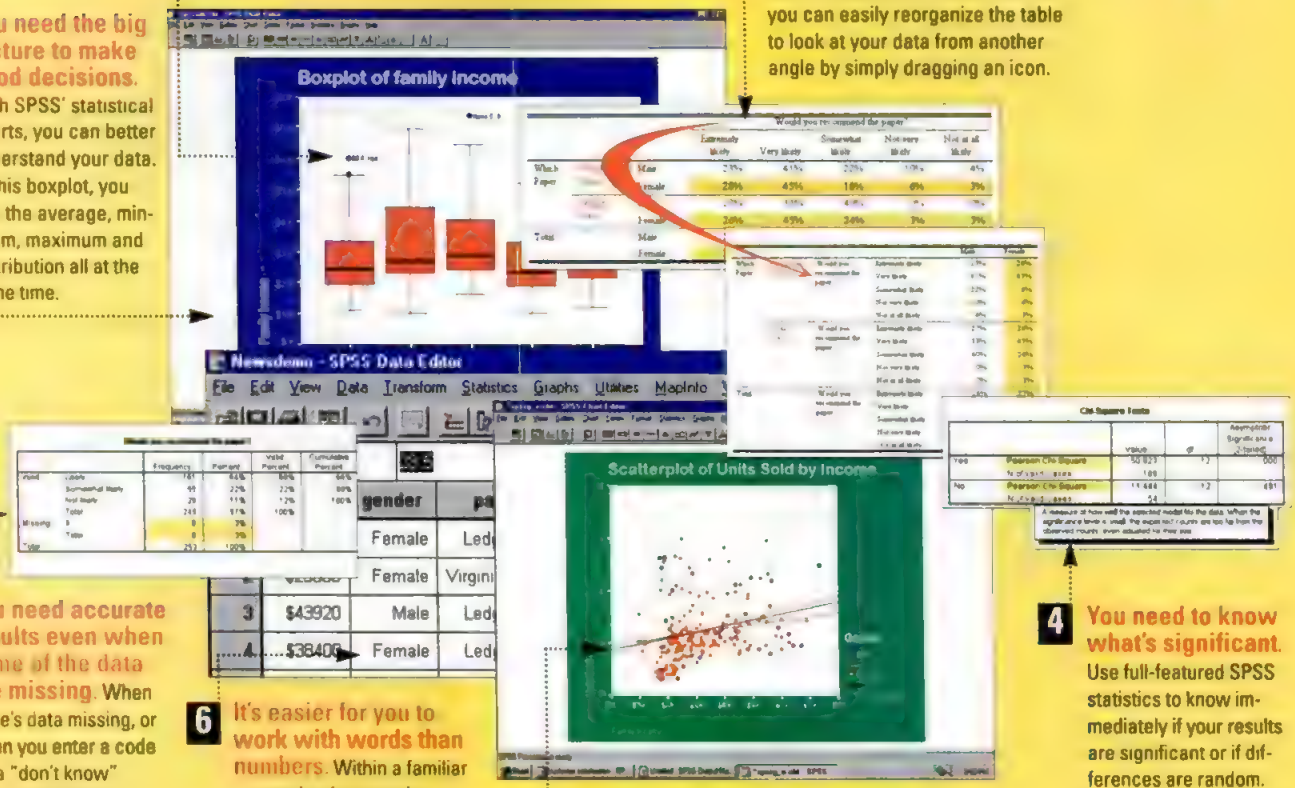

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1280MB	Caviar	10ms	128	5,200	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	WD2120AA	209.99
1620MB	Caviar	10ms	128	5,200	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	WD3160AA	249.99
2113MB	Caviar	12ms	128	5,200	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	WD3210AA	299.99
2559MB	Caviar	12ms	128	5,200	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	WD3250AA	379.99
Seagate										
810MB	Marathon	16ms	120	4,500	16.6Mbytes	2.5" 19.15MM	Fast ATA-2	3 Year	ST9816AG	$399.99
541MB	Cabo 541	14ms	64	3,600	16.6Mbytes	3.5" 1"H	Fast ATA-2	3 Year	ST3541A	179.99
631MB	Medalist XE	14ms	120	3,811	[illegible]	3.5" 1"H	Fast ATA	3 Year	ST3630A	179.99
1062MB	Cabo 1060	14ms	64	3,600	16.6Mbytes	3.5" 1"H	Fast ATA-2	3 Year	ST3106A	CALL
1275MB	Cabo 1276	12.5ms	64	4,500	16.6Mbytes	3.5" 1"H	Fast ATA-2	3 Year	ST31276A	229.99
1623MB	Cabo 1621	14ms	64	3,600	16.6Mbytes	3.5" 1"H	Fast ATA-2	3 Year	ST31621A	239.99
1262MB	Medalist SL	10.5ms	128	5,400	16.6Mbytes	3.5" .75"H	Fast ATA-2	3 Year	ST51270A	215.99
2113MB	Medalist	10ms	128	5,400	16.6Mbytes	3.5" 1.02"H	Fast ATA-2	3 Year	ST32140A	289.99
4250MB	Medalist	10.5ms	128	5,400	16.6Mbytes	3.5" 1.02"H	Fast ATA-2	3 Year	ST34250A	CALL
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TOSHIBA										
810MB	Slimline	13ms	128	4,200	13.3Mbytes	2.5" 12.7MM	Fast ATA	1 Year	MK1926FCV	$379.99
1300MB	Slimline	13ms	128	4,200	13.3Mbytes	2.5" 12.7MM	Fast ATA	1 Year	MK1301MAV	599.99
1300MB	Notebook	13ms	128	4,200	13.3Mbytes	2.5" 19MM	Fast ATA	1 Year	MK2720FC	599.99
2100MB	Notebook	13ms	128	4,200	13.3Mbytes	2.5" 19MM	Fast ATA	1 Year	MK2101MAN	CALL
FUJITSU										
1090MB	Winchester	12ms	64	4,500	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	FJ1614A	$205.99
Quantum										
850MB	Trailblazer	14ms	128	4,500	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	QUTR850A	$199.99
1286MB	Bigfoot	15.5ms	128	3,600	16.6Mbytes	5.25" .75"H	Fast-ATA-2	3 Year	QUBF1286A	219.99
1280MB	Fireball	12ms	128	5,400	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	QUFB1280A	225.99
1708MB	Sirocco	11ms	128	4,500	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	QUSR1700A	299.99
2577MB	Bigfoot	15.5ms	128	3,600	16.6Mbytes	5.25" .75"H	Fast-ATA-2	3 Year	QUBF2577A	389.99
2550MB	Sirocco	11ms	128	5,400	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	QUSR2550A	399.99
Maxtor®										
1084MB	Durango	11ms	64	4,500	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	MX71084A	$199.99
1336MB	Durango	11ms	64	4,500	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	MX71336A	229.99
1670MB	Durango	11ms	64	4,500	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	MX71620A	239.99
2004MB	Durango	11ms	64	4,500	16.6Mbytes	3.5" 1"H	Enhanced IDE	3 Year	MX72004A	299.99
[redacted]										
1080MB	Deskstar	10.5ms	512	5,400	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	IB94G3186	$269.99
1700MB	Deskstar	12ms	128	4,500	16.6Mbytes	3.5" 1"H	Fast-ATA-2	3 Year	IBO6H8724	329.99

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Capacity**	Model	Access	Cache	RPM	Max Trnsf. Rate	Form/Ht.	Interface	Mfr.'s Wty.	Prod. Code	Price
Seagate										
1050MB	Hawk 2XL	9ms	512	5,411	20Mbytes	3.5" 1"H	Ultra SCSI	5 Year	ST31055N	$375.99
2149MB	Hawk 2XL	9ms	512	5,411	20Mbytes	3.5" 1"H	Ultra SCSI	5 Year	ST32155N	629.99
2149MB	Hawk 2XL	9ms	512	5,411	40Mbytes	3.5" 1"H	Ultra Wide SCSI	5 Year	ST32155W	659.99
2150MB	Cayman	8.5ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2 A/V	5 Year	ST3207N	679.99
4294MB	Hawk 4	9ms	512	5,411	10Mbytes	3.5" HH	Fast SCSI-2 A/V	5 Year	ST15230N	979.99
4294MB	Cayman	9ms	512	7,200	10Mbytes	3.5" HH	Fast SCSI-2 A/V	5 Year	ST1420?N	899.99
Performance Drives—										
2147MB	Barracuda 2LP	8ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2 A/V	5 Year	ST32550N	765.99
2147MB	Barracuda 2LP	8ms	512	7,200	20Mbytes	3.5" 1"H	Fast Wide SCSI-2 A/V	5 Year	ST32550W	819.99
2150MB	Barracuda 4LP	8ms	512	7,200	20Mbytes	3.5" 1"H	Ultra SCSI	5 Year	ST32171N	CALL
2150MB	Barracuda 4LP	8ms	512	7,200	40Mbytes	3.5" 1"H	Ultra Wide SCSI	5 Year	ST32171W	CALL
4294MB	Barracuda 4	8ms	1,024	7,200	10Mbytes	3.5" HH	Fast SCSI-2 A/V	5 Year	ST15150N	1,099.99
4294MB	Barracuda 4	8ms	1,024	7,200	20Mbytes	3.5" HH	Fast Wide SCSI-2 A/V	5 Year	ST15150W	1,129.99
4294MB	Barracuda 4	8ms	1,024	7,200	20Mbytes	3.5" HH	Fast Wide SCSI/SCA	5 Year	ST15150WC	1,149.99
4350MB	Barracuda 4LP	8ms	512	7,200	20Mbytes	3.5" 1"H	Ultra SCSI	5 Year	ST34371N	CALL
4350MB	Barracuda 4LP	8ms	512	7,200	40Mbytes	3.5" 1"H	Ultra Wide SCSI	5 Year	ST34371W	CALL
9090MB	Elite 9	11ms	1,024	5,400	[illegible]	5.25" FH	Fast SCSI-2 A/V	5 Year	ST410800N	CALL
9090MB	Elite 9	11ms	1,024	5,400	20Mbytes	5.25" FH	Fast Wide SCSI-2 A/V	5 Year	ST410800W	CALL
9100MB	Barracuda 9	8ms	512	7,200	20Mbytes	3.5" HH	Ultra SCSI	5 Year	ST19171N	CALL
9100MB	Barracuda 9	8ms	512	7,200	40Mbytes	3.5" HH	Ultra Wide SCSI	5 Year	ST19171W	CALL
MICROPOLIS										
2100MB	Taurus	8.5ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2	5 Year	MC4221S	$659.99
4300MB	Capricorn	8.5ms	512	7,200	10Mbytes	3.5" HH	Fast SCSI-2	5 Year	MC3243S	1,029.99
9100MB	Scorpio	12ms	512	5,400	10Mbytes	5.25" FH	Fast SCSI-2	5 Year	MC1991	1,999.99
2100MB	Taurus	8.5ms	512	7,200	20Mbytes	3.5" 1"H	Fast Wide SCSI-2 A/V	5 Year	MC4221AVW	899.99
4300MB	Capricorn	8.5ms	512	7,200	20Mbytes	3.5" HH	Fast Wide SCSI-2 A/V	5 Year	MC3243AVW	1,249.99
9100MB	Scorpio	12ms	512	5,400	20Mbytes	5.25" FH	Fast Wide SCSI-2 A/V	5 Year	MC1991AVW	2,229.99
Quantum										
1080MB	Fireball	12ms	128	5,400	10Mbytes	3.5" 1"H	Fast SCSI-2	3 Year	QUFB108OS	$269.99
1280MB	Fireball	11ms	128	5,400	10Mbytes	3.5" 1"H	Fast SCSI-2	3 Year	QUFB128OS	319.99
2150MB	Atlas	8ms	1,024	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2	5 Year	QUXP3125S	679.99
2150MB	Atlas	8ms	1,024	7,200	20Mbytes	3.5" 1"H	Fast Wide SCSI-2	5 Year	QUXP3125W	729.99
4300MB	Atlas	8ms	1,024	7,200	10Mbytes	3.5" HH	Fast SCSI-2	5 Year	QUXP3430S	999.99
4300MB	Atlas	8ms	1,024	7,200	20Mbytes	3.5" HH	Fast Wide SCSI-2	5 Year	QUXP3430W	1,079.99
[redacted]										
2100MB	Ultrastar	7.5ms	512	7,200	10Mbytes	3.5" 1"H	Fast SCSI-2	5 Year	IB94G3O54	$1,049.99
4500MB	Ultrastar/XP	8ms	512	7,200	10Mbytes	3.5" HH	Fast SCSI-2	5 Year	IB94G3196	1,499.99
2100MB	Ultrastar	7.5ms	512	7,200	20Mbytes	3.5" 1"H	Fast Wide SCSI-2	5 Year	IB94G3O55	1,049.99
4500MB	Ultrastar/XP	8ms	512	7,200	20Mbytes	3.5" HH	Fast Wide SCSI-2	5 Year	IB94G3O57	1,399.99
5310MB	Ultrastar	8ms	512	5,400	20Mbytes	3.5" HH	Fast Wide SCSI-2	5 Year	IB94G3O59	1,449.99

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PRO32OO+ $55.99
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- 2 Serial ports, 1 Parallel port

DTC 32bit PCI, Enhanced IDE controller
DTC2130D $39.99
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Qlogic 16bit PCI, Fast SCSI-2 controller
QLFSPCIOEM $129.99
- 10Mb/Sec. Max. Sustained transfer rate
- Corel SCSI software
- 50 pin SCSI-2 external connector

Adaptec PCI, Fast Wide SCSI controller
AD3940WOT $529.99
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- Floppy support and Corel SCSI software

Adaptec 32bit PCI, Fast Wide Ultra SCSI-3 controller
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IBM												
ThinkPad 365E	Intel® 486C	10.4" Dual Scan	8/24MB	540MB	–	TrackPoint III	NiMH	5.8	1yr	IBT2625W9A	$79.99	$1,999.99
ThinkPad 365XD	Pentium® 100	10.4" Dual Scan	8/40MB	540MB	4X	TrackPoint III	NiMH	6.2	1yr	IBT26256E3	117.99	2,949.99
ThinkPad 365XD	Pentium® 120	10.4" Active Matrix	8/40MB	1.08GB	4X	TrackPoint III	NiMH	6.0	1yr	IBT2625DEF	143.51	3,899.99
ThinkPad 760EL	Pentium® 100	11.3" Dual Scan	8/72MB	810MB	–	TrackPoint III	Lith Ion	6.7	3yr	IBT9547U6G	125.11	3,399.99
ThinkPad 760EL	Pentium® 120	11.3" Dual Scan	8/72MB	1.08GB-R	–	TrackPoint III	Lith Ion	6.7	3yr	IBT9547U4F	180.31	4,899.99
ThinkPad 760ELD	Pentium® 100	12.1" Black Active	8/72MB	810MB-R	4X	TrackPoint III	Lith Ion	7.3	3yr	IBT9547U3F	165.99	4,499.99
ThinkPad 780E	Pentium® 133	12.1" Black Active	16/80MB	1.08GB-R	–	TrackPoint III	Lith Ion	6.8	3yr	IBT9546U4A	220.79	5,999.99
ThinkPad 780E	Pentium® 133	12.1" Black Active	16/80MB	1.2GB-R	4X	TrackPoint III	Lith Ion	7.4	3yr	IBT9546U3A	247.09	6,899.99
Toshiba												
Satellite 100CS	Pentium® 75	10.4" Dual Scan	8/40MB	528MB	–	Bit-in AccuPoint	NiMH	6.9	1yr	TA1ØØCS	$78.79	$1,999.99
Satellite Pro 410CS	Pentium® 90	11.3" Dual Scan	8/40MB	810MB	Opt.	Bit-in AccuPoint	Lith Ion	6.8	3yr	TA41ØCS7	117.75	3,199.99
Portege 610CT	Pentium® 90	9.5" Active Matrix	8/40MB	720MB	–	Bit-in AccuPoint	Lith Ion	4.8	3yr	TA61ØCT8	118.86	3,229.99
Tecra 700CS	Pentium® 120	11.3" Dual Scan	8/40MB	1.2GB	Opt.	Bit-in AccuPoint	Lith Ion	7.3	3yr	TA7ØØCS	142.37	3,868.99
Tecra 720CDT	Pentium® 133	12.1" Active Matrix	16/144MB	1.2GB-R	Bit-in	Bit-in AccuPoint	Lith Ion	8.0	3yr	TA72ØCDT	224.18	6,349.99
Toshiba Re-Manufactured												
Satellite Pro T2135CS	486DX4/75	10.4" Dual Scan	8/32MB	520MB	–	Bit-in AccuPoint	NiMH	6.8	1yr	TA2135CSB	$55.99	$1,399.99
Satellite Pro T2135CS	486DX4/75	10.4" Dual Scan	8/32MB	520MB	–	Bit-in AccuPoint	NiMH	6.8	1yr	TA2135CSWB	55.99	1,399.99
Satellite Pro T2155CDS	486DX4/75	10.4" Dual Scan	4/28MB	520MB	Bit-in	Bit-in AccuPoint	NiMH	6.9	1yr	TA2155CDSB	63.99	1,599.99
Satellite Pro T2155CDS	486DX4/75	10.4" Dual Scan	4/28MB	520MB	Bit-in	Bit-in AccuPoint	NiMH	6.9	1yr	TA2155CDWB	63.99	1,599.99
Satellite Pro 400CS	Pentium® 75	10.4" Dual Scan	8/40MB	810MB	Opt.	Bit-in AccuPoint	Lith Ion	6.8	1yr	TA4ØCS7B	99.99	2,499.99
Satellite Pro 400CS	Pentium® 75	10.4" Dual Scan	8/40MB	810MB	Opt.	Bit-in AccuPoint	Lith Ion	6.8	1yr	TA4ØCS7WB	99.99	2,499.99
Satellite Pro 410CS	Pentium® 90	11.3" Dual Scan	8/40MB	810MB	Opt.	Bit-in AccuPoint	Lith Ion	6.8	1yr	TA41ØCS7B	115.99	2,899.99
Satellite Pro 410CDT	Pentium® 90	11.3" Active Matrix	8/40MB	810MB-R	Rmov.	Bit-in AccuPoint	Lith Ion	7.3	1yr	TA41ØCDT7B	150.87	4,099.99
Portege 610CT	Pentium® 90	9.5" Active Matrix	8/40MB	720MB	–	Bit-in AccuPoint	Lith Ion	4.8	1yr	TA61ØCT8WB	111.99	2,799.99
Tecra 700CS	Pentium® 120	11.3" Dual Scan	8/40MB	1.2GB	Opt.	Bit-in AccuPoint	Lith Ion	7.3	1yr	TA7ØØCSB	136.15	3,899.99
Tecra 700CT	Pentium® 120	11.3" Active	16/48MB	1.2GB	Opt.	Bit-in AccuPoint	Lith Ion	7.3	1yr	TA7ØØCTB	169.27	4,599.99
Texas Instruments												
Extensa 510	Pentium® 100	11.3" Dual Scan	8/40MB	810MB	–	Touch Pad	NiMH	5.9	3yr	TEXT51Ø	$90.39	$2,259.99
Extensa 570CD	Pentium® 100	11.3" Dual Scan	8/40MB	810MB	6X	Touch Pad	Adv. NiMH	6.4	3yr	TEXT57ØCD	115.99	2,899.99
Extensa 570CDT	Pentium® 100	10.4" Active Matrix	8/40MB	1.2GB	6X	Touch Pad	Adv. NiMH	6.4	3yr	TEXT57ØCDT	144.82	3,929.99
TravelMate 5100	Pentium® 90	10.4" SVGA	8/32MB	1.2GB	–	"The Point"	2 Lith	6.7	3yr	TEXTP9ØCTC	123.50	3,355.99
TravelMate 5200	Pentium® 120	11.3" SVGA	8/32MB	1.2GB	–	"The Point"	2 Lith	6.7	3yr	TEXT52ØØC	151.83	4,125.99
TravelMate 5300	Pentium® 133	11.3" SVGA	8/32MB	1.2GB	–	"The Point"	2 Lith	6.7	3yr	TEXT53ØØ	162.50	4,415.99
AST												
Ascentia J10	Pentium® 75	10.4" Dual Scan	8/40MB	500MB-R	–	"Track Stick"	Lith Ion	5.8	3yr	5Ø1788-3Ø1	$85.99	$2,149.99
Ascentia J10	Pentium® 75	10.4" Dual Scan	8/40MB	800MB-R	–	"Track Stick"	Lith Ion	5.8	3yr	5Ø1788-4Ø1	94.23	2,355.99
Ascentia J30	Pentium® 100	10.4" Dual Scan	8/40MB	800MB-R	–	"Track Stick"	Lith Ion	5.8	3yr	5Ø1945-4Ø1	105.99	2,649.99
Ascentia J30	Pentium® 100	10.4" Active Matrix	8/40MB	800MB-R	–	"Track Stick"	Lith Ion	5.8	3yr	5Ø1946-4Ø1	113.83	2,845.99
Ascentia J50	Pentium® 133	10.4" Active Matrix	8/40MB	800MB-R	–	"Track Stick"	Lith Ion	5.8	3yr	5Ø1947-4Ø1	122.02	3,315.99
Ascentia P30	Pentium® 100	11.3" Dual Scan	8/40MB	800MB-R	4X	Touch Pad	Lith Ion	5.8	3yr	5Ø1996-3Ø1	122.02	3,315.99
Ascentia P30	Pentium® 100	11.3" Dual Scan	8/40MB	1.2GB-R	4X	Touch Pad	Lith Ion	5.8	3yr	5Ø1996-4Ø1	141.16	3,835.99
Ascentia P50	Pentium® 133	11.3" Active Matrix	8/40MB	800MB-R	4X	Touch Pad	Lith Ion	5.8	3yr	5Ø1997-3Ø1	158.82	4,315.99
Ascentia P50	Pentium® 133	11.3" Active Matrix	8/40MB	1.2GB-R	4X	Touch Pad	Lith Ion	5.8	3yr	5Ø1997-4Ø1	176.49	4,795.99
NEC												
Versa 4050H	Pentium® 90	10.4" Active Color	8MB	810MB-R	Opt.	VersaGlide	Lith Ion	6.7	3yr	NCV49ØCT8H	$150.36	$4,085.99
Versa 2200C	Pentium® 75	10.4" Active Color	8MB	810MB-R	–	VersaGlide	Lith Ion	6.5	3yr	NCVRS22ØØC	95.19	2,379.99
Versa 4080H	Pentium® 120	10.4" Active Color	8MB	1GB-R	Opt.	VersaGlide	Lith Ion	6.4	3yr	NCVRS4Ø8ØH	161.91	4,399.99

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Toshiba Tecra 700CS, CT	8MB KTT700/8 ..... 249.99	16MB KTT700/16 ..... 469.99	32MB KTT700/32 ..... 899.99
Toshiba T2110, T2130, T2150	8MB KT2100/8MB 179.99	16MB KT2100/16MB 349.99	
Toshiba Portege 610CT, 410, 710, 720	8MB KTT610/8 ..... 209.99	16MB KTSP16MB 389.99	32MB KTT610/32 ..... 749.99
AST J10, J30, J50	8MB KTAST J/8 ..... 189.99	16MB KTAST J/16 ..... 369.99	32MB KTAST J/32 ..... 699.99
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IBM 770C	8MB KT353056 ..... 189.99	16MB KT353057 ..... 399.99	32MB KT727444 ..... 1,399.99
IBM 760E, EL, ED, ELD	8MB KT760E/8 ..... 209.99	16MB KT760E/16 ..... 409.99	
TI TravelMate 5000, 5100, 5200	8MB KT2777/8 ..... 189.99	16MB KT2777/16 ..... 389.99	
TI Extensa 550, 560, 570	8MB KT550/8 ..... 189.99	16MB KT550/16 ..... 369.99	32MB KT550/32 ..... 699.99
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Model	Speed	Transfer Rate	Access	Buffer	Interface	Int./Ext.	Product Code	Price
PLEXTOR								
4Plus	4.5X	675KB/S	130ms	256K	SCSI	Internal	ODTX43CE	$249.99
45 Plus	4.5X	675KB/S	130ms	256K	SCSI	External	ODTX45CE	349.99
6PleX	6X	900KB/S	145ms	256K	SCSI	Internal	ODTX6PLEX	279.99
65PleX	6X	900KB/S	145ms	256K	SCSI	External	ODTX65PLEX	379.99
8 Plex	8X	1200KB/S	115ms	256K	SCSI	Internal	ODTX83CS	379.99
CREATIVE CREATIVE LABS, INC.								
6 speed IDE	6X	900KB/S	220ms	256K	IDE	Internal	MMCLD6X	$129.99
8 speed IDE	8X	1200KB/S	220ms	256K	IDE	Internal	MMCLSB8X	249.99
HILITE featuring Sony mechanisms								
77E	4.5X	685KB/S	190ms	128K	IDE	Internal	ODSO77EB	$99.99
76S	4X	600KB/S	190ms	256K	SCSI	Internal	ODSO76SB	149.99
SONY								
Diskman	2X	300KB/S	295ms	128K	PCMCIA	External	ODSOPRD15Ø	$399.99
Diskman w/sound	2X	300KB/S	295ms	128K	PCMCIA	External	ODPRD15ØS	649.99
In Touch with Tomorrow TOSHIBA								
3701	6.5X	1000KB/S	135ms	256K	SCSI	Internal	ODTO37Ø1	$279.99
3701E	6.5X	1000KB/S	135ms	256K	SCSI	External	ODTO37Ø1E	349.99
T5522A	6X	900KB/S	190ms	256K	IDE	Internal	ODTO5522B	129.99
TEAC								
CD56A	6X	900KB/S	145ms	128K	IDE	Internal	ODCD56AB	$149.99
NEC								
NC502	6X	900KB/S	145ms	256K	SCSI	Internal	ODNC5Ø2	$279.99
NC602	6X	900KB/S	145ms	256K	SCSI	External	ODNC6Ø2	379.99
7 disc changer	4X	600KB/S	350ms	256K	SCSI	External	ODNCC3Ø2	359.99
4 disc changer	4X	600KB/S	250ms	128K	IDE	Internal	ODNCC251	199.99
TALON MULTI MEDIA								
4 speed	4X	600KB/S	220ms	256K	IDE	Internal	ODMITK	$69.99
6 speed	6X	900KB/S	210ms	128K	IDE	Internal	ODTA6X	99.99
8 speed	8X	900KB/S	210ms	128K	IDE	Internal	ODTA8X	129.99
PIONEER								
124X	4.4X	676KB/S	140ms	256K	SCSI	Internal	ODPNE124X	$209.99
6 disk changer	4.4X	676KB/S	150ms	256K	SCSI	External	ODDRM624X	299.99
Panasonic								
D720 discman	2X	300KB/S	295ms	128K	PCMCIA	External	ODPND72Ø	$299.99
D740 discman	4X	600KB/S	295ms	128K	PCMCIA	External	ODPND74Ø	399.99
D745 w/sound	4X	600KB/S	295ms	128K	PCMCIA	External	ODPND745	499.99
MC684 IDE	4X	600KB/S	200ms	256K	IDE	Internal	ODPNMC684	249.99
MC604S	4X	600KB/S	200ms	256K	SCSI	Internal	ODPNMC6Ø4S	399.99
MicroSolutions								
Backpack	4X	600KB/S	250ms	128K	Parallel	External	ODMSBACK	$279.99
Backpack w/sndcrd	4X	600KB/S	250ms	128K	Parallel	External	ODMSBACKS1	379.99
HITACHI								
CDR-773Ø	4X	600KB/S	240ms	256K	IDE	Internal	ODHTQUAD	$79.99
Acer								
Acer 6X	6X	900KB/S	210ms	128K	IDE	Internal	ODACER6X	$99.99
Acer 8X	8X	1200KB/S	190ms	128K	IDE	Internal	ODACER8X	129.99
DISCTEC								
Roadrunner	4X	600KB/S	220ms	256K	Parallel	External	ODROAD4X	$249.99
Roadrunner	6X	900KB/S	220ms	256K	Parallel	External	ODROAD6X	319.99
Octek								
Octek	8X	1200KB/S	210ms	256K	IDE	Internal	ODOCT8X	$129.99

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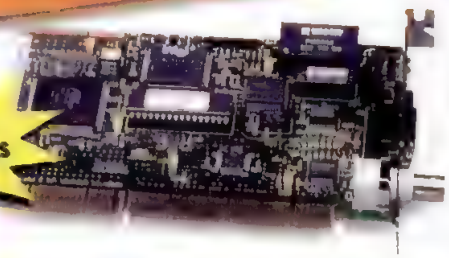

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EtherExpress Pro/10, ISA, Flash, Combo, 5 Pack	NWIN820SB5	549.99
EtherExpress Pro/10, ISA, Combo, 20 Pack	NWIN820SB2	1,999.99
EtherExpress Pro/10, IPCI, TP	NWINT8465	219.99
EtherExpress Pro/100, TX, PCI, TP	NWINT8465	145.99
NetportExpress XL, Combo	NWINT2131	439.99
NetportExpress EL, Combo	NWINT2141	399.99
Express Stackable Hub 100Base-T	NWINT1ØØTX	1,699.99
12 Port Express Hub TP w/10 Pro 100 Adapters	NWINT1ØØWG	2,089.99

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Accessories	Product Code	Price
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Kingston Remote Novell PROM	KT167496	$25.99
3Com Boot ROM for 3C5X9 series	NW3C5Ø9-NW	45.99
Intel Boot ROM	NWINTB81ØØ	45.99
SMC Universal Boot ROM for EtherEZ	NWSMCUROM	39.99
Patch Cables		
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Coax, 15'	NWCOAX-15	6.99
Coax, 25'	NWCOAX-25	9.99
Coax, 50'	NWCOAX-5Ø	15.99
TP or RJ-45, 7'	NWRJ45-7	5.99
TP or RJ-45, 10'	NWRJ45-1Ø	6.99
TP or RJ-45, 14'	NWRJ45-14	7.99
TP or RJ-45, 25'	NWRJ45-25	10.99
TP or RJ-45, 50'	NWRJ45-5Ø	15.99
TP or RJ-45, 100'	NWRJ45-1ØØ	30.99
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BNC Terminator Cap, 10 pack	NWTERM1Ø	$19.99
BNC "T" Connector, 10 pack	NWTCON1Ø	19.99
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3COM ISOLAN Ethernet Transceiver BNC TAP	NW3C1114-3	$115.99
3COM ISOLAN Transceiver with Vampire Tap to AUI	NW3C114-1	115.99
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Etherlink III ISA, TP	NW3C5Ø9BTP	99.99
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Etherlink III ISA, Combo, 5 pack	NW3C5Ø9BC5	519.99
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Etherlink III PCI, TP	NW3C59ØTP	139.99
Etherlink III PCI, Combo	NW3C59Ø-C	169.99
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Fast Ethernet 10/100, PCI, TP	NW3C595TX	$169.99
Fast Ethernet 10/100, EISA, TP	NW3C597TX	239.99
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Linkbuilder Hub, 12 port, TP	NW3C1617Ø	$319.99
Linkbuilder Hub, FMS,12 port, TP	NW3C1627-1	629.99
Linkbuilder Hub, FMS II, 24 port, TP	NW3C16671	949.99
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Etherlink IIIB PC Card, Combo	NW3C589COM	$199.99
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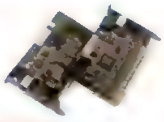

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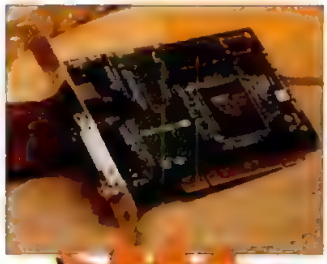

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Asante Etherpac, ISA, TP	NWASØØ3Ø4	49.99
Asante Plug N Play TP 8 Port Hub	NWASØØ279	139.99
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Asante Plug N Play TP 24 Port Hub	NWASOO281	475.99
Asante 1016-IQ Ethernet Hub 16 Port TP 1 AUI, 1 BNC, w/SNMP	NWASØØ294	719.99
Asante AsanteView Windows 2.5 3.5" Software	NWASØØ291	299.99
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Asante Bridge 10/100	NWASØØ365	889.99
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Asante AsanteFast Ethernet Hub 12 Port 100Base-TX	NWASØØ371	1,499.99
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EtherPower 10/100 PCI, TP & DB-9	NWSMC9332	149.99
EtherPower PCI, Combo	NSMC8432T	139.99
EtherPower PCI, TP	NWSMC8432T	115.99
Ether 10/100 EISA BNC TP AUI Combo	NWSMC9232D	249.99
Tigerhub 100 Fast Ethernet	NWSMC5116T	2,329.99
TigerStack 3328T Ether Hub, 28 port, RJ-35, TP	NWSMC3328T	929.99
TigerStack 3312TC Hub 12 port TP	NWSMC3312	509.99
TigerStack 3314TC Hub 14 port TP stackable	NWSMC3314T	539.99
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SMC EZ Switch	NWSMCEZØØ6	999.99
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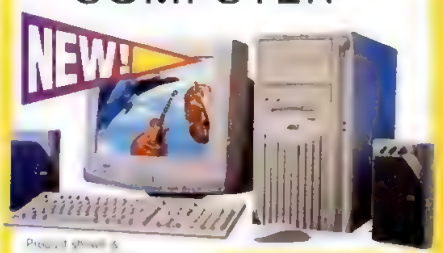

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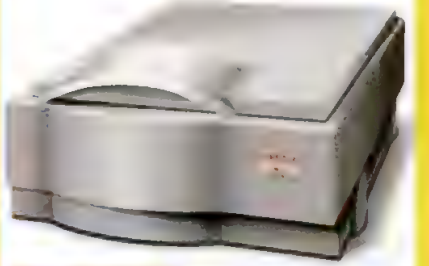

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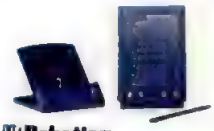

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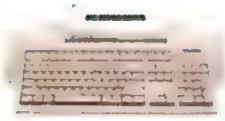

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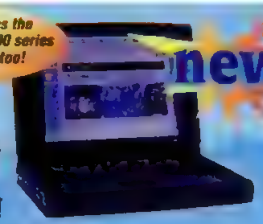

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3C595 Fast Etherlink PCI 10/100BT	161.91
3C16170 Linkbuilder TP/12 port	315.36
3C16670 Linkbuilder FMS/II 12 port	511.86

Artisoft

NodeRunner/SI 2000T	71.80
NodeRunner Pro combo	79.33
NodeRunner/SI 2000A	84.98
T-Runner II 8-port 10BT	164.43
T-Runner II 16-port 10BT	322.93
LANtastic V6.0	74.34
LANtastic V6.0 5 user	304.88
LANtastic V6.0 starter kit coax	225.30
LANtastic V6.0 add-on kit 10BT	117.93
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Intelligent AutoSwitch 4 computers to 1 printer	35.94
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SNAP starter kit 2 computers to 1 printer	109.80
SNAP add-on transmitter	41.92

Bay Networks

SynOptics System 800 10BT 8-port hub	204.00
SynOptics System 800M 10BT 8-port hub	536.80

IBM

Token Ring auto adapter 16/4 ISA	217.15
Token Ring MAU multiport	385.99

NETWORKING PRODUCTS

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EtherExpress 16 10BT	99.40
EtherExpress 16 10BT 5 pack	458.76
EtherExpress 16 combo	123.25
EtherExpress 16 combo 5 pack	542.71
EtherExpress EISA coax	402.82
EtherExpress MCA 10BT	172.09
EtherExpress PRO/10+Mbps ISA	98.23
EtherExpress PRO/100Mbps EISA	252.17
EtherExpress PRO/100Mbps PCI	139.01
EtherExpress PRO/100Mbps PCI 5 pack	638.54
NetportExpress EL Ethernet	373.30
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LINKSYS

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EtherPower 10BT PCI	117.38
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EtherPower coax PCI 5 pack	665.62
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ARCNET 8-port active hub coax	223.65
ARCNET PC600WS coax	119.86
Ethernet 8-port 10BT hub	291.98
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Wyse 60 amber/green/white	316.80
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PE10B2C pocket Ethernet coax	304.12
PE10BT pocket Ethernet 10BT	266.01
PT316CTP pocket Token Ring III	448.10
PPX03 Parallel port multiplexor	78.66

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Jumbo 1400 internal	226.67
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T1000 800MB Travan w/tape	181.24
T1000E 800MB parallel port	189.66

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Tape*Stor 3200MB internal	236.18
Tape*Stor 4GB internal EIDE	335.24

EXABYTE

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Eagle96 TBU	172.87

iomega

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Jaz drive 1GB cartridge	124.00

MICROSOLUTIONS

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Discovery 4x CD PnP multimedia kit	274.48
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Sound Blaster AWE32 PnP	222.43

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Sony PRO-150 portable Discman® PCMCIA Type II	342.66
Sony 4X CD SCSI-2 internal	158.00
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MICROTEK

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Mag Innovision DX17T 17" .26mm	729.77
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Mag Innovision MX21F 21" .28mm	1484.25
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Magnavox CM1215 15" .28mm	369.77
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NEC M500 15" .25mm	569.01
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NEC XV17+ 17" .28mm	799.84
NEC XP17 17" .28mm	1037.70
NEC XP21 21" .28mm	1943.57
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Samsung 17GLi 17" .28mm	749.00
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V

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microLaser Pro/8	1107.16
microLaser PowerPro/12	1382.58

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Acculogic SIDE-3+ w/on-board BIOS	37.18
Acculogic SIDE-4+ w/par 2 serial game	27.74
Acculogic SIDE-4VL EIDE 16550 serial	68.24
Adaptec AVA1505 SCSI 2 CD Kit	48.32
Adaptec 2842 VLB SCSI 2	239.11
Adaptec 1542CP SCSI Master Kit	249.57
Adaptec PCI Ultra Wide SCSI Kit	289.53
Adaptec Power Storage ISA Kit	809.48
Adaptec Power Storage PCI Kit	809.48
Promise 2300+ EIDE VLB	48.47

MODEMS & COMMUNICATIONS

BOCA

Online Express 14.4 internal w/fax	46.82
Online Express 14.4 external w/fax	67.87
V.34 28.8 internal w/fax	147.46
V.34 28.8 external w/fax	209.84

Hayes

ACCURA 144 internal w/fax	79.09
ACCURA 144 external w/fax	94.51
ACCURA 288 V.34 internal w/fax	152.89
ACCURA 288 V.34 external w/fax	168.68
OPTIMA 288 V.34 internal w/fax	359.58
OPTIMA 144 external w/fax	371.72
OPTIMA 288 Business Modem	429.70

MICROCOM

DeskPorte 28.8P V.34 external	234.16
DeskPorte 28.8S Fast V.34, external	181.73

MOTOROLA

14.4 VoiceSURFR internal	81.09
14.4 VoiceSURFR external	112.86
BitSURFR ISDN adapter internal	263.97
BitSURFR ISDN adapter external	283.63
BitSURFR Pro ISDN terminal adapter	348.03
ModemSURFR V.34 internal	145.83
ModemSURFR V.34 external	167.58
OnlineSURFR V.34 Package internal	155.25
OnlineSURFR V.34 Package external	178.74

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PUREDATA

SatisFAXtion 14.4 internal	269.29
SatisFAXtion 28.8 internal	389.96

Microcom

14.4 internal w/fax	65.88
14.4 Mini Tower w/fax	79.05
V.34 28.8 internal w/fax	141.13
V.34 28.8 Mini Tower w/fax	159.94

Supra

Supra 288 faxmodem internal	168.17
Supra 288 faxmodem external	193.74
SupraExpress 288PNP internal	123.48
SupraExpress 288PNP external	141.13
Supra Simple Internet 288i internal	129.54
Supra Simple Internet 288i external	129.95

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SPORTSTER MODEMS

14.4 internal w/fax	96.52
14.4 external w/fax	113.62
28.8 V.34 internal w/fax	169.29
28.8 V.34 external w/fax	184.45
Voice 28.8 V.34 internal w/fax	184.45
Voice 28.8 V.34 external w/fax	212.13
Winmodem 28.8 internal w/fax	142.75

COURIER MODEMS

V.34 internal w/fax	339.12
V.34 external w/fax	361.19
I-modem ISDN modem internal	562.15
I-modem ISDN modem external	632.84

ZOOM

28.8 V.34 FaxModem internal	143.48
28.8 V.34 FaxModem external	159.94
14.4 V.32bis Voice Speakerphone internal	114.99
28.8 V.34 Voice Speakerphone internal	184.51

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Back UPS Pro 420 Plug and Play	233.42
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SmartUPS 1000	496.46
SmartUPS 1400	621.50
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SurgeArrest Professional	27.29
SurgeArrest Network	29.34

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BC PERS 420	126.49
BC PERS 500	156.25
BC PRO 550	181.42
BC PRO 675	213.24
BC PRO 850	275.86
BC PRO 1050	309.20
Isobar 4 OUTLET	38.99
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OmniSmart 280 PNP	133.93
OmniSmart 450 PNP	204.75
OmniSmart 675 PNP	234.21

PCMCIA CARDS

3Com Etherlink III	156.76
3Com Etherlink IIIC combo	379.84
Adaptec APA1460 SCSI-2	164.24
Hayes EZJack 14.4 w/fax	163.46
Hayes EZJack 28.8 V.34 w/fax	219.00
IBM 14.4 modem	48.50
IBM 28.8 data/fax modem	289.66
IBM Ethernet adapter 10BT	123.67
IBM Token Ring 16/4	287.29
Linksys Ethernet combo	135.70
Megahertz 10BT Enet adapter w/XJACK	133.03
Megahertz 28.8 V.34 data/fax w/ XJACK	259.96
Megahertz 28.8 V.34 cellular w/XJACK	459.67
Megahertz 28.8/Enet cellular w/XJACK	491.10
Megahertz 28.8/Enet combo cellular w/XJACK	427.94
Motorola Montana 28.8 cellular	252.32
Motorola Mariner 28.8 data/fax & LAN cellular	466.52
New Media Bus Toaster SCSI-2 host	189.89
New Media Wave Jammer sound card	221.41
Simple 14.4 modem + voice	98.70
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Simple 28.8 Communicator	247.79
SMC EtherEZ 28.8/Ethernet 10BT	419.08
SMC EtherEZ 28.8/Ethernet combo	458.76
USR Sportster 28.8 V.34 with DataView	243.27
Xircom Ethernet 10BT	139.23
Xircom Ethernet combo	182.33
Xircom Ethernet+modem 14.4 10BT	266.19
Xircom Ethernet+modem 14.4 combo	306.65
Xircom Ethernet+modem 28.8 10BT	349.13
Xircom Ethernet+modem 28.8 combo	417.33
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HP 5000/Twinhead Slimnote 8 Series, 16Meg	319.00
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Compaq LTE LITE, 486, 4Meg	79.00
HP 5L, 4Meg	89.00
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256 x 3-70, 30 Pin	.60
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IBM 6450603, 1Meg	10.00
IBM 6450604, 2Meg	20.00
NEC Versa, 32Meg	399.00

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	50NS	60NS	70NS	80NS	100NS
1Meg x1	–	6.95	6.45	5.95	4.95
1Meg x4	–	49.00	39.00	36.00	–
1Meg x4 Zip Pk	–	24.00	22.00	21.00	–
256x4 Page Dip	–	7.75	6.75	6.00	5.00
256 x 4 Static Zip	–	–	11.00	–	–
256x4 Page Zip	–	9.00	8.00	8.95	–
256x4 Video Zip	–	–	10.95	9.00	7.95
256x9(SIMM)	–	19.00	16.00	–	–
256 x1	–	3.00	2.95	2.75	2.00
64x4	–	–	–	3.75	–
64x1	–	–	–	–	2.00
256x16 SOJ	–	39.00	39.00	–	–
256x16 SOJ, Sstc	–	39.00	–	–	–
256x16 Video Zip	–	49.00	39.00	–	–

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80387-16 DX	39.00
80387 20 DX	44.00
80387-DX (Does All)	49.00
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1Meg x 9 (3 chip)	–	–	–	24.00	13.00	12.00
1Meg x 9 (9 chip)	–	–	–	24.00	22.00	21.00
4Meg x 9	–	–	–	64.00	60.00	60.00
16Meg x 9 (9 chip)	–	–	–	289.00	279.00	279.00

72 PIN SIMMS (EISA), EDO

	50NS	60NS	70NS
256 x 36 1 Meg	55.00	50.00	45.00
512 x 36 2 Meg	99.00	90.00	80.00
1 meg x 36 4 Meg	54.00	48.00	46.00
2 x 36 8 meg	199.00	179.00	169.00
4 x 36 16 meg	1375.00	1325.00	1299.00
8 x 36 32 meg	2499.00	2399.00	2299.00
16 x 36 64 meg	1379.00	1350.00	1350.00
1 x 32 4 meg	44.00	40.00	36.00
2 x 32 8 meg	74.00	69.00	64.00
4 x 32 16 meg	154.00	144.00	134.00
8 x 32 32 meg	308.00	308.00	315.00
1 x 32 4 meg EDO	44.00	41.00	41.00
2 x 32 8 meg EDO	79.00	74.00	69.00
4 x 32 16 meg EDO	154.00	149.00	149.00
8 x 32 32 meg EDO	329.00	319.00	319.00

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1 x 64	8Meg	179.00
2 x 64	16Meg	349.00
4 x 64	32Meg	699.00
8 x 64	64Meg	Call
1 x 72	8Meg	179.00
2 x 72	16Meg	349.00
4 x 72	32Meg	699.00
8 x 72	64Meg	Call
1 x 72 3.3V	8Meg	179.00
2 x 72 3.3V	16Meg	349.00
4 x 72 3.3V	32Meg	699.00
8 x 72 3.3V	64Meg	Call
1x EDO	8Meg	179.00
2x EDO	16Meg	349.00
4x EDO	32Meg	699.00
8x EDO	64Meg	Call

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64Meg	2199.00
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32Meg	599.00
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32Meg	659.00
64 Meg	3299.00
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72 Pin 3.3V	16Meg	299.00
72 Pin 3.3V	32 Meg	Call
72 Pin 5V	4Meg	74.00
72 Pin 5V	8Meg	149.00
72 Pin 5V	16Meg	299.00
72 Pin 5V	32 Meg	Call
144 Pin 3.3V	4Meg	Call
144 Pin 3.3V	8Meg	199.00
144 Pin 3.3V	16Meg	399.00
144 Pin 3.3V	32 Meg	799.00
144 Pin 5V	4Meg	Call
144 Pin 5V	8Meg	249.00
144 Pin 5V	16Meg	Call
144 Pin 5V	32 Meg	Call

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MODEL	AMT. UPGRADED	AST PART #	PRICE
Bravo LC Series, Bravo MT, Bravo MS, MS-C, Advantage Pro DX33 SX25	4Meg	50096 -002	49.00
	8Meg	50096 -003	99.00
	16Meg	50096 -004	209.00
	32Meg	50096 -005	419.00
	64Meg	50096 -006	999.00
Premmia LX P/60, M54/66d, 4/100T P/60	4Meg	501340-001	99.00
	8Meg	501340-002	209.00
	32 Meg	50096 -005	419.00
	64 Meg	501569-001	Call
Premmia 6133, 4133S, 4/50d, 4/80d	8 Meg	501159-002	209.00
Premmia SE 4/33 4/66d P/60	16 Meg	501159-003	399.00
Premmia MTE 4/33, 4/66d, P/90	32 Meg	501159-004	578.00
Manhattan GL Series Server	64 Meg	501159-005	1077.00
Power Premium 3133, 4/33, 4/33S, 4/50d, 4/66d	8Meg	500780-001	199.00
Premmia 486/25, 486/25E, 486/33, 486/33E			
Premmia 486/33T, 486/25TE, 486/33TE			
Prem. 486/25, 386/33, 486/33, 486 SX/20			
Bravo 486/25, 486/33	2 Meg Kit	500780-005	69.00
Advantage 486/25, 486/33, 486/33P, 486 SX/20			
Premmia 564/25	8Meg Kit	500780-001	199.00
Premmia SE 560, 566 P/60	1 Meg	500780-003	54.00
Prem. 386/33, 386 SX/16 Prem. 386SX/20 386/25	4Meg	500780-004	99.00
Premmia GX P/60, P/100	8Meg Kit/16Meg Kit	501565-001/501566-001	159.00
	32Meg Kit/64Meg Kit	501567-001/501568-001	578.00
AST Expid Board	8-32 Meg	4800A-B-001	159.00

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Ambra 486/25, 486/33	4,8,16 Meg	49.00/99.00/199.00
Ambra 486SL	4,8,16 Meg	49.00/99.00/199.00
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IBM PART NO	WORKS WITH MODEL NO	PRICE
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[illegible] (2Meg)	[illegible]	39.00
6450608 (2Meg)	[illegible]	49.00
34F2533 (4Meg)	[illegible]	79.00
87F9977 9G7180 (4Meg)	[illegible]	79.00
92F9935 (2Meg)	[illegible]	69.00
92F9934 (4Meg)	[illegible]	89.00
92G7256 (4Meg)	[illegible]	89.00
4Meg SIMMs 1 4Meg=32Meg	PC 300 Series	40-94-7505-019
4Meg SIMMs 1 4Meg=32Meg	PC 700 Series	40-94-7505-019
4Meg SIMMs 1 4Meg=32Meg	PC Power Series	40-94-7505-019
4Meg SIMMs 1 4Meg=32Meg	PC Server 300, 325, 520	40-94-7505-019
4Meg SIMMs 1 4Meg=32Meg	PC Server 500	2758419-019
92F7334 (16Meg 70ns pin Edge)	IBM 750/750	299.00
92F7335 (32Meg 100 pin Edge)	IBM 730/750	749.00
92G7529 4Meg	[illegible]	49.00
92G7541 8Meg	[illegible]	94.00
92G7543 16Meg	[illegible]	209.00
92G7545 (32Meg)	Aptiva 310 330 350 510 530 710 750 Portfolio	419.00
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79G3120 92G7202 (8Meg)	[illegible]	129.00
90G1825 92G7204 (16Meg)	[illegible]	259.00
92G7205 (32Meg)	Value Point Performance PC Server 4/66	649.00
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84G8139 92G7200 (4Meg)	Value Point 77 486DX2 486SX SVR 85	69.00
84G9129 92G7428 (8Meg)	365X 465X	129.00
84G9130 92G7202 (8Meg)	56 57 57SX 90 95 P 75 57SLC	129.00
84G1158 92G7206 (4Meg ecc)	[illegible]	109.00
90G7096 92G7179 (16Meg ecc)	[illegible]	399.00

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85G0094 (4Meg)	Thinkpad 755, 360, 355, 340, 450	105.00
85G0094 (8Meg)	Thinkpad 755, 360, 355, 340, 450	189.00
85G0095 (16Meg, 32Meg)	Thinkpad 755, 360, 355, 340, 450	349.00
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79F1000 (4Meg)	L440, N33SX, PS Note, Tspd 360, 380c, PS Note 425	119.00
79F1001 (8Meg)	L440, N33SX, PS Note	219.00
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60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	399.00
4Meg, 8Meg, 16Meg	Thinkpad 300	179.00/319.00
92G7258 (1Meg)	Thinkpad 701C, CS, Butterfly	89.00
92G7261 (4Meg)	Thinkpad 701C, CS, Butterfly	149.00
92G7263 (16Meg, 32Meg)	Thinkpad 701C, CS, Butterfly	339.00
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Deskpro 386 25E/20E	1Meg Module, 4Meg Module	79.129
	1Meg Board, 4 Meg Board	99.201
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Deskpro System Pro 386/33, 486/25, 486/50L	2,8,32Meg	89.199.499
Deskpro 486, 4/33, 4/25S, 3733, 3/25i	2,4,16Meg	54.99.199
Deskpro 'M' Series	Expansion Board 0K	119
Deskpro 450, 466, 4100, 575, 590, 5120, 5133	4,8,16,32Meg	89.129.259.497
Deskpro XE 4/33, 450, 466	4,8,16Meg	89.129.259
Deskpro XE 560	4,8,16,32,64Meg	49.94.209.419.899
Deskpro XL 450, 466, L 560, 4/66, XL575, 5100 i/560	4,8,16,32,64Meg	49.94.209.419.899
Presario 433 CDS520 CDJV520 CDL524 CDS526 CDTV528 CDS528 666, CDS660, CDS720, CDS724, CDS744, CDS800 CDS920, CDTV920, 924, CDS924, CDS954	4,8,16,32Meg	49.94.209.419
Presario 400 Series, 600 Series, 800 Series	4,8,16,32Meg	49.94.209.419
Presario 7174, CDS672, CDS682, CDTV678, CDS874 (in pairs)	4,8,16,32Meg	49.94.209.419
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Prolinea 4/25S, 4/33, 4/33S, 4/50, 4/66, CDS	2,8,32,64Meg	39.69.99.129
Prolinea 4/33S, 4/5C, 4/66 Tempo/ex 4/33S, 4/50S, 4/50, 4/66	4,8,16,32Meg	89.129.259.497
Prolinea 450, 466, 4100, 575, 590, 5120, 575, 580, 5120, 575, 5100 mini, 5133 mini	4,8,16,32Meg	89.129.259.497
Prolinea 1500, 5/75, 5/100, 1500P, 5/75P, 5/100P (install in pairs)	4,8,16,32Meg	49.94.209.419
Prosignia 300, 575, 580, 590, 590i, 500 5/120 (install in pairs)	4,8,16,32Meg	49.94.209.419
ProLinea 1000, 5/60 Prosignia 5/60 (install in pairs)	4,8,16,32Meg	49.94.209.419
ProLinea 2000, 486/50, 5/66, 5/90, 2000R, 5/66, 5/90 (install in pairs)	4,8,16,32Meg	49.94.209.419
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5000, 5200, 5280	4Meg, 16Meg, 32Meg, 64Meg		219.419.799.1529
LTE/386S/20	4Meg Module	121125-002	119.00
LTE, LTE/20, 25, 25C	4Meg Module	129789-002	119.00
LTE, LTE/20, 25, 25C	8Meg Module	129789-003	209.00
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LTE LITE 425C/33C/25E/25L	4Meg Module	142327-002	119.00
LTE LITE 425C/33C/25E/25L	8Meg Module	142327-003	219.00
LTE 425C/33C/25E/25L	16Meg Module	142327-004	399.00
SLT 386	4Meg Module	113305-001	99.00
Concerto LTE Elite	4Meg	144790-001	119.00
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Contura 320, 325	4Meg	144790-003	349.00
	8Meg	138498-001	99.00
	16Meg	138499-001	199.00
Contura 400, 410, 420, 430	4Meg, 8Meg, 16Meg		99/199/349
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	99.00
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Tecra 700, 710, 720	810Meg, 1.3Gig		739.799
3100, 3105, 3110, 3115, 3120, 3125, 3130	4Meg, 8Meg, 16Meg, 4 Mx	P# PA2000	49.99.199
3100, 3105, 3150, 3155, 3160, 3125, 3135	4Meg, 8Meg, 16Meg, 4 Mx		119.254.44
T4400CS, SXC, T6400, T6600	1Mx	P#	49
4400 C, T4600, T4700, T1600 C, T1650 C	1Mx	P#	49
T4400CS, SXC, T6400, T6600	2Mx	P#	49
4500 C, T4600, T4700, T1600 C, T1650 C	2Mx	P#	49
4500 C, T4600, T4700, T1600 C, T1650 C	4Mx	P# PA2000	49
T8000, 8100	4Mx	P# PA2000	49
T4400CS, 4500CT, T1600, T1650	4Meg, 8Meg, 32Meg		159.319.699

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MODEL	AMT. UPGRADED	MANU. PART #	PRICE
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ACER 750, 760, 780, 784, 786, 787	4Meg, 8Meg, 16Meg		99.199.399
ACER 920	4Meg, 8Meg, 16Meg		99.199.399
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Canon Navio 486 10	4Meg, 8Meg, 16Meg	92F3277-001, -002	99.199.399
Canon Notetel 486	4Meg, 8Meg, 16Meg	92F3278-001, -002	99.199.399
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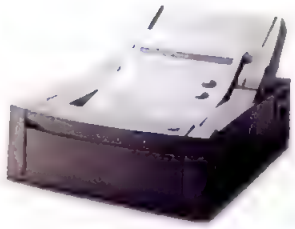

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7 Drive CD ROM TOWERS (1-21 Drive towers & other brands available!)
Sony 4X $1549 NEC 4X $1489 Pioneer 4.4X $2029
NEC 6X $2679 Toshiba 6.7X $2549 Toshiba 8X $3449

REMOVABLES

OPTICAL DRIVES

230MB	Fujitsu DynaMO Bare	$419
230MB	Fujitsu DynaMO Parallel Ext with 1 disk	$439
230MB	Fujitsu DynaMO PC Ext w/controller, & 1 disk	$499
2.6Gig	Maxoptix Int/Ext	$1925/$2025
2.6Gig	HP Int/Ext	$2125/$2225

SYQUEST DRIVES

EZ 135MB •13.5ms, 3600rpm, 128K buffer, 3 1/2" drive
Internal IDE with disk / External SCSI with disk $190/$199
External parallel port with 1 disk $249
270MB • 13.5ms, 3600rpm, 128K buffer, 3 1/2" drive
Internal IDE (SQ3270A)/ with 1disk ($3270AC) $299/$339
External for parallel port with 1 disk $429
SCSI drive (SQ3270S)/SCSI external($3270X) $339/$399
200MB •15.7ms, 3220rpm, 64K buffer, 5 1/4" form factor.
SCSI drive (SQ5200)/SCSI external(SQ5200CX) $339/ $399
Genuine Syquest Media Qty 2-5/5-9/10+ or with drive
44MB $48/43/40 88MB $53/48/45 105MB $56/54/51
135MB $27/24/21 200MB $79/74/71 270MB $60/58/55

IOMEGA DRIVES

100MB ZIP • 3.5" x 1" high form factor
External SCSI w/ 1 disk $199
Parallel External w/ 1 disk $199
1 Gig JAZ • 3.5" x 1" high form factor
Internal SCSI w/ 1 disk $499
External SCSI w/ 1 disk $599

Adaptec controller A1505CDKIT only $49 when purchased with Zip or Jaz drive.

TAPE DRIVES

Prices include 1 free tape! Save $10 with hard drive!

1 Gig	Seagate	$159	800MB	Seagate	$141
1.7Gig	Seagate	$219	4.4Gig	Seagate	$259

Parallel External for printer port 1 Gig $269

SCSI TAPE DRIVES (bare, no tape)

2Gig	HP	DAT	$609	2-4Gig	Seagate	DAT	$679
2Gig	Seagate	DAT	$599	4-8Gig	Seagate	DAT	$859
2-4Gig	Seagate	QIC	$349	4-8Gig	HP	DAT	$879
2-4Gig	HP	DAT	$699	7-14Gig	Exabyte	8mm	$1889

HOT PRODUCTS

ExaByte 8mm EXB-8700 Tape Drive

The sleek, stand alone drive features a 7-gigabyte native, or 14-gigabyte compressed capacity, backup rate of up to 60 megabyte-per-minute. Complete backup kit includes: External drive w/ cable, 1 tape, 1 cleaning tape, and a CD ROM w/ Arcada backup for DOS/WIN and your choice of Arcada for NetWare, Arcada for NT, Cheyenne for NetWare, or Palindrome backup director.

$1489 alone or $1479 with hard drive purchase.
Also available without software. $1149

Plug-N-Play Hard Card

Out of drive bays? Looking for an easy way to upgrade your hard drive storage capacity? This hard disk card from *Smart Storage Solutions* is the answer. Just insert the card in a 16 bit slot. It comes preformatted and will work in any 386 or higher computer.

1Gig [SSS1GIG]	$299	2Gig [SSS2GIG]	$439
1.6Gig [SSS1.6GIG]	$399	2.5Gig [SSS2.5GIG]	$499

Fixed Disk Performance With all the Removability Advantages

MCD

3 1/2" x 1" drive, 10ms 2 year drive warranty, 5 year cartridge warranty. Compatible with SyQuest 270 media.

Internal SCSI with 1 cartridge	$389
External SCSI with 1 cartridge	$449
Parallel Ext with 1 cartridge	$519

SCSI HARD DRIVES

SCSI	Speed	RPM	Brand	Model	Wty	Price
850MB	14ms	4500	Quantum	TB850S	3	$195
1050MB	9ms	5400	Seagate	ST31051N	3	$349
1080MB	11ms	5400	Seagate	ST51080N	3	$235
1280MB	12ms	5400	Quantum	FB1280S	3	$276
2050MB	8.5ms	7200	Micropolis	MC4221	5	$544
2050MB	8.5ms	7200	Micropolis	MC4221AV	5	$600
2147MB	9ms	5400	Micropolis	MC4421	5	$444
2147MB	9ms	5400	Seagate	ST32151N	5	$600
2147MB	8ms	7200	Seagate	ST32550N	5	$675
2150MB	8ms	7200	Quantum	XP32150	5	$630
4290MB	8ms	7200	Seagate	ST15150N	5	$989
4290MB	9ms	5400	Seagate	ST15230N	5	$905
4294MB	8.9ms	7200	Micropolis	MC3243	5	$859
4294MB	8.9ms	7200	Micropolis	MC3243AV	5	$945
4300MB	8.6ms	7200	Quantum	XP34300	5	$900
9091MB	12ms	5400	Micropolis	MC1991	5	$1840
9091MB	12ms	5400	Micropolis	MC1991AV	5	$1959
9080MB	11ms	5400	Seagate	ST410800N	5	$1880
WIDE SCSI						
2050MB	8.9ms	7200	Micropolis	MC4221W	5	$630
2050MB	8.9ms	7200	Micropolis	MC4221WAV	5	$689
2147MB	8ms	7200	Seagate	ST32550W	5	$675
2150MB	8ms	7200	Quantum	XP32150W	5	$680
4294MB	8.9ms	7200	Micropolis	MC3243W	5	$945
4294MB	8.5ms	7200	Micropolis	MC3243WAV	5	$1035
4294MB	8ms	7200	Seagate	ST15150W	5	$1065
4300MB	8.6ms	7200	Quantum	XP34300W	5	$959
9080MB	11ms	5400	Seagate	ST410800W	5	$2029
9100MB	12ms	5400	Micropolis	MC1991W	5	$1929
9100MB	12ms	5400	Micropolis	MC1991WAV	5	$2049

SCSI CONTROLLERS

Save $10 when you purchase any SCSI controller with any SCSI drive.

ADAPTEC

Adaptec kits include controller, cable, and EZ-SCSI software to support hard drives, Optical, Removable, CD ROM.

1505	ISA 16Bit SCSI (no hard drive support)	$60
1515	ISA 16Bit SCSI	$97
1520	ISA, PIO, 10MB/s	$145
1522	ISA 16Bit SCSI, Floppy	$155
1540	Bare, ISA, Bus Master	$199
1542	ISA 16Bit Busmaster SCSI, Floppy	$270
1640	MicroChannel SCSI	$339
2742	EISA 32Bit SCSI, Floppy	$379
2842	Local Bus 32Bit SCSI, Floppy	$255
2920	PCI 32Bit SCSI (PIO)	$169
2940	PCI 32Bit SCSI (Bus Master)	$239
2940UW	PCI ULTRA WIDE SCSI	$295
T348	Bidirectional Parallel to SCSI	$105
T358	EPP to SCSI adapter	$139
T1460	PCMCIA type 2, 3, or 4 to SCSI	$195
A3940	Twin Channel PCI SCSI (14 Drives)	$439
A3940W	Twin Channel PCI WIDE SCSI	$529
A2825KIT	VESA Local Bus IDE & SCSI	$135

We stock RAID controllers for PCs and Macintoshes. Call!

REMOVABLE DRIVE BRACKET

Converts any 3 1/2" hard drive into a removable drive. Great for transportability, data interchange, or security needs. Extremely high quality construction. Metal cartridge and frame, cooling fan, SCSI unit has ID select on the cartridge. Qty discounts available.

	System	Extra Cartridge	Extra Frame
IDE	$79	$39	$49
SCSI	$85	$40	$54
WIDE SCSI	$129	$64	$75

IDE HARD DRIVES

IDE	Speed	RPM	Brand	Model	Wty	Price
631MB	14ms	3800	Seagate	ST3630A	3	$170
639MB	11ms	4500	Western Digital	AC2635	3	$170
850MB	10ms	4500	Western Digital	AC2850	3	$182
850MB	14ms	4500	Quantum	TB850A	3	$185
1080MB	11ms	5400	Seagate	ST51080A	3	$196
1080MB	9.5ms	5400	Fujitsu	M1606T	3	$209
1084MB	14ms	4480	Maxtor	M71084A	2	$200
1090MB	11ms	4500	Fujitsu	M1614T	3	$195
1250MB	15ms	3600	Quantum	BF1250A	3	$200
1280MB	12ms	5400	Quantum	FB1280A	3	$216
1280MB	10ms	5200	Western Digital	AC21200A	3	$205
1282MB	10.5ms	5400	Seagate	ST51270A	3	$207
1330MB	12ms	4480	Maxtor	M71336A	3	$207
1624MB	10ms	5200	Western Digital	AC31600	3	$249
1625MB	10.5ms	5400	Seagate	ST31640A	3	$275
1626MB	12ms	4480	Maxtor	M71626AP	3	$249
1700MB	11ms	4500	Quantum	SR31700A	3	$247
2004MB	12ms	4480	Maxtor	M72004A	3	$289
2100MB	10ms	5200	Western Digital	AC32100	3	$310
2167MB	10ms	5400	Seagate	ST32140A	3	$299
2500MB	15ms	3600	Quantum	BF2500A	3	$319
2500MB	11ms	4500	Quantum	SR32550A	3	$335
2559MB	11ms	5200	Western Digital	AC32600	3	$350

IDE CONTROLLERS

Save $5 when you purchase any IDE controller with any IDE drive.

TEKRAM

DC200E, ISA, 2 IDE, 2 flop, 2 (16550) ser, 1 (EPP) par, 1 game	$40
DC280E, VESA, 4 IDE, 2 flop, 2 (16550) ser, 1 (EPP) par, 1 game	$55
DC290S, PCI, 4 IDE, Bus Mastering	$39
DC600CD, 16Bit ISA, 4 IDE, 2 ATAPI, caching, RAID 1	$90
DC680CD, 32Bit VESA Local Bus, 4 IDE, 2 ATAPI, caching, RAID 1	$109
DC690CD, 32Bit PCI Bus, 4 IDE, 2 ATAPI, caching, RAID 1	$139

GSI

GSI controllers have on board BIOS to allow any size drive to be used in any system without the use of device drivers. Will run in conjunction with other controllers.

GSI1533-1B, ISA, 2 IDE	$41
GSI1533-21, ISA, 2 IDE, 4 floppy	$53
GSI1533-32, ISA, 2 IDE, 4 floppy, 2 ser, 1 par	$100
GSI1533-4C, ISA, 8 IDE	$119
GSI1645-V1, VESA extender, requires GSI ISA	$74
GSI VESA combo kit 18&V1 $109 21&V1 $121	
GSI VESA REQUIRES NO DEVICE DRIVERS!	

Promise

EIDEMAX, ISA, 2 IDE	$36
EIDE2300+, VESA, 4 IDE, 2 flop, 2 ser, 1 par	$59
EIDE4030+, VESA, 6 IDE, 2 flop, 2 ser, 1 par, 1 game, caching	$143

Other

IDEHDCT, ISA, 2 IDE, 2 floppy	$9

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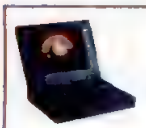

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Ascentia P30 5/100
8/800MB Dual 4XCD
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Ascentia P30 5/100 8/1200MB/CD Dual	$3700
Ascentia P50 5/133 8/800MB/CD Active	4200
Ascentia P50 5/133 8/1200MB/CD Active	4650

Ascentia J Series - Call for details!

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15GS 15" (13.7v) .28mm	$265
15GA 15" (14.0v) .28mm	350
17GS 17" (15.7v) .27mm	470
17PS 17" (15.7v) .27mm	645
21PS 21" (19.7v) .28mm	1150
PT810 21" (19.5v) .25mm	1580

EPSON
Stylus Color II Inkjet
$30 manufacturer's mail-in rebate
$299

Stylus Color II 720 dpi Color Inkjet	$299
Stylus Color IIs 360 dpi Color Inkjet	210
Stylus Color Pro 720 dpi Color Inkjet	499
Stylus Color ProXL 720 dpi Color Wide	1700
LQ570+ Dot Matrix	246
DFX5000+ Dot Matrix	1400

US Robotics
Sportster
28.8 Win modem
$181

Sportster Internal 28.8 V.34	$135
Sportster Voice 28.8 V.34 Internal	178
Sportster External 28.8 V.34	203
Sportster Voice 28.8 V.34	203
Sportster ISDN 128 kbps	370

NOTEBOOKS

CTX	Price
Ez 500T 5x86/100 8/810MB Active	$1799
Ez 600T 5/75 8/540MB/CD Active	Call
Ez 655T 5/90 8/810MB Active	Call
Ez 660T 5/90 16/810MB Active	Call
IBM	
760L 5/90 8/810MB Active	$4050
760LD 5/90 8/810MB/CD Active	4350
760E 5/133 16/1090MB 12.1" Active	5900
760ELD 5/100 8/810MB 4XCD 12.1" Active	4400
760ED 5/133 16/1200MB 4XCD 12.1" Active	6900
NEC	
2200C 5/75 8/810MB Active	$2300
4000C 5/75 8/540MB Active	3150
4000CD 5/75 8/810MB/CD Active	3600
4050CD 5/90 8/810MB/CD Active	4300
4050H 5/90 8/810MB Active	3900
TEXAS INSTRUMENTS	
Extensa 510 5/100 8/810MB Dual	$2199
Extensa 560CD 5/75 8/810MB/CD Dual	2380
Extensa 510 5/100 8/810MB 6XCD Dual	2880
Extensa 560CDT 5/75 8/1200MB/CD Active	3350
TM5100 5/90 8/1200MB Active	3350
TM5200 5/120 8/1200MB Active	4050
TM5300 5/133 8/1200MB Active	4550
TOSHIBA	
T410CS 5/90 8/810MB Dual	$3100
T610 5/90 8/720MB Active	3100
T700CS 5/120 8/1200MB Dual	3900
T720CDT 5/133 16/1200MB/CD 12.1 Active	6200

MONITORS

ACER	Price
55 15" (13.6 v) .28mm	$334
56e 15" (13.6 v) .28mm	356
76se 17" (15.6 v) .27mm	626
98i 21" (19.8 v) .28mm	1761
CTX	
1451C 14" (13.0 v) .28mm	$233
1451CLR 14" (13.0 v) .28mm	242
1565D 15" (14.0 v) .28mm	350
1765GMe 17" (16.0 v) .27mm	619
1785GMe 17" (16.0 v) .26mm	674
17XA 17" (16.0 v) .25mm	910
2085 20" (19.0 v) .28mm	1100
MAG	
DX1495 14" (13.4 v) .28mm	$255
DX1595 15" (13.7 v) .28mm	375
DX1795 17" (15.9 v) .26mm	650
MX21F 21" (20.0 v) .28mm	1500
NEC	
MultiSync XV15+ 15" (13.8 v) .28mm	$470
MultiSync XV17+ 17" (15.6 v) .28mm	795
MultiSync XP17 17" (15.6 v) .28mm	1030
MultiSync XE21 21" (19.8 v) .28mm	1680
MultiSync XP21 21" (19.8 v) .28mm	1950
SONY	
CPD-1425 14" (13.1 v) .25mm	$292
Multiscan 15sfII 15" (13.9 v) .25mm	465
Multiscan 15sxII 15" (13.9 v) .25mm	385
Multiscan 17sfII 17" (16.0 v) .25mm	850
Multiscan 20sfII 20" (19.1 v) .30mm	1650

PRINTERS

CANON	Price
BJC-4100 720x360 dpi Color Inkjet	$290
BJC-610 720 dpi Color Inkjet	435
LBP-460 600 dpi Laser	370
HEWLETT PACKARD	
DeskJet 340 300 x 600 dpi Black Portable	$291
DeskJet 600C 600 dpi Color Inkjet	241
DeskJet 680C 600 dpi Color Inkjet	310
DeskJet 855CXI 600 dpi Color Inkjet	475
DeskJet 1600C 600 dpi Color Inkjet	1330
LaserJet 5L-FS 600 dpi Laser	495
LaserJet 5P 600 dpi Laser	860
LaserJet 5MP 600 dpi Laser	1000
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LaserJet 5N 600 dpi Ethernet	1500
LaserJet 5M 600 dpi PC/Mac Ethernet	1730
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Color LaserJet 5 300 dpi Color Laser	5630
LEXMARK	
Optra E 600 dpi Laser	$545
Optra R+ 1200 dpi Laser	1280
Optra Rt+ 1200 dpi Laser	1500
Optra Lx+ 1200 dpi Laser	1830
Optra Lxi+ 1200 dpi Laser	2630
Optra C 600 dpi Color Laser	5000
OKIDATA	
OKIJET 2010 600x300 dpi Color Inkjet	$265
OL600e 600 dpi LED	385
OL610e 600 dpi LED	490
OL610e/PS 600 dpi LED PostScript	685
OL810e 600 dpi LED	745
OL810e/PS 600 dpi LED PostScript	1080
OL1200 600 dpi LED	965
OL1200/PS 600 dpi LED PostScript	1330

MODEMS

CARDINAL	Price
MVP 28.8I Int. Fax/Modem	$112
MVP 28.8IV Int. Voice/Fax/Modem	158
MVP 28.8XV Ext. Voice/Fax/Modem	176
MOTOROLA	
BitSurfr Pro ISDN External	$330
ModemSurfr 28.8 Modem/Fax Internal	135
ModemSurfr 28.8 Modem/Fax Internal	143
Marquis 28.8 V.34 Data/Fax/Ethernet	384

STORAGE

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Caviar 850MB EIDE	183
Caviar 1280MB EIDE	219
CONNER	
Filepro 635MB EIDE	$181
Filepro 850MB EIDE	201
Filepro 1275MB EIDE	220
QUANTUM	
Fireball 1080MB SCSI	$251
Fireball 1280MB EIDE	218
Bigfoot 1286MB EIDE	196
Bigfoot 2577MB EIDE	300
SEAGATE	
ST1220A 1.0GB EIDE	$202
ST32140 2.0GB 3.5" EIDE	310
ST15230N 4200MB 3.5" SCSI II	999
IOMEGA	
ZIP 100MB PC Parallel	$194
Ditto Tape Drive 3200MB Internal	235
Ditto Tape Drive 3200MB External	289
COLORADO	
Jumbo 1400MB	$225
T1000 800MB Internal	156

COMPUTERS

AST	Price
Bravo LC 5/100 16/1200MB	$1430
Bravo MS 5/120 16/1600MB	1900
Bravo LC 5/133 8/1200MB	1550
Bravo LC 5/166 16/1600MB	1900

MULTIMEDIA

ACER	Price
8X Internal CD-ROM drive	Call
CREATIVE	
Sound Blaster AWE32 PNP	$214
Discovery CD 8X Internal	330
Blaster CD 8X IDE Internal PNP	221
Performance 8X PNP	385
DIAMOND	
Multimedia Kit 8000	$319
PANASONIC	
KXL-D740 Portable Quad	$196
Big 5 4X Changer	283

VIDEO CARDS

DIAMOND	Price
Stealth 64 Graphics 2200 2MB DRAM PCI	$113
Stealth 64 Video 3200 2MB VRAM PCI	248
Edge 3D 2200XL 2MB PCI DRAM	204
Edge 3D 3240XL 2MB PCI VRAM	340
Edge 3D 3400XL 4MB PCI VRAM	465
Javelin Video 3400XL 4MB PCI	405
NUMBER NINE	
9FX Vision 330 2MB VLB	$70
9FX Motion 331 2MB PCI DRAM	110
9FX Motion 771 2MB PCI	280
9FX Motion 771 4MB PCI	425
Imagine 128 Series 2 4MB PCI	600
MATROX	
MGA Millenium 3D 2MB PCI	$300
STB	
Powergraph 64 2MB PCI	$143
Horizon 64 1MB PCI	105
HERCULES	
MGA Millenium 3D 2MB PCI	$300

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EPSON	Price
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ES-1000C 400 x 800 dpi Color Flatbed	735
ES-1200C 600 x 600 dpi Color Flatbed	935
ES-1200C Pro 600 x 600 dpi Color Flatbed	1130
MICROTEK	
ScanMaker E3 300 x 600 dpi Color Flatbed	$365
ScanMaker E6 600 x 1200 dpi Color Flatbed	545
ScanMaker E6 Pro 600 x 1200 dpi Color	725
UMAX	
Vista-S6E SOHO 300 x 600 dpi Color Flatbed	$375
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Vista-S12 PCLE2 600 x 1200 dpi Color Flatbed	735
Vista-S12 PCPRO2 600 x 1200 dpi	825
Gemini D-16 PC LE2 400 x 800 dpi	1300
Gemini D-16 PC PRO2 400 x 800 dpi	1400
PowerLook II PCPRO2 w/UTA 600 x 1200 dpi	2230

SOFTWARE

LOTUS	Price
SmartSuite 96 Windows 95 Upgrade CD-ROM	$140
SmartSuite 96 Windows 95 CD-ROM	380
1-2-3 V 5.0 Multimedia	291
MICROSOFT	
Exchange V 4.0 Internet Mail	$500
Front Page V. 1.0	141
Windows 95 Upgrade	86
Office Pro Windows 95 Upgrade	300
POWERSOFT	
Powerbuilder Desktop V 4.0	$168
Funky for Powerbuilder V 4.0	188
Portfolio	370
QUARTERDECK	
Cleansweep 95 for Windows 95	$23

515MCX 5/133
16/1620MB 4XCD
$2450

510C 5/120 8/1200MB	$1400
510MC 5/100 8/1280MB 4XCD	1730
515CD 5/100 8/1280MB 4XCD	1630
515MC 5/133 8/1620MB	1780
510MCX 5/100 8/1280MB	1800
515MCX 5/166 8/1280MB 4XCD	2980

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Graphics Xpression 1MB ISA	$102
Graphics Xpression 2MB VLB	148
WinTurbo 2MB PCI	226
Graphics Pro Turbo 2MB PCI	248
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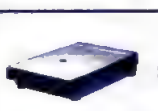

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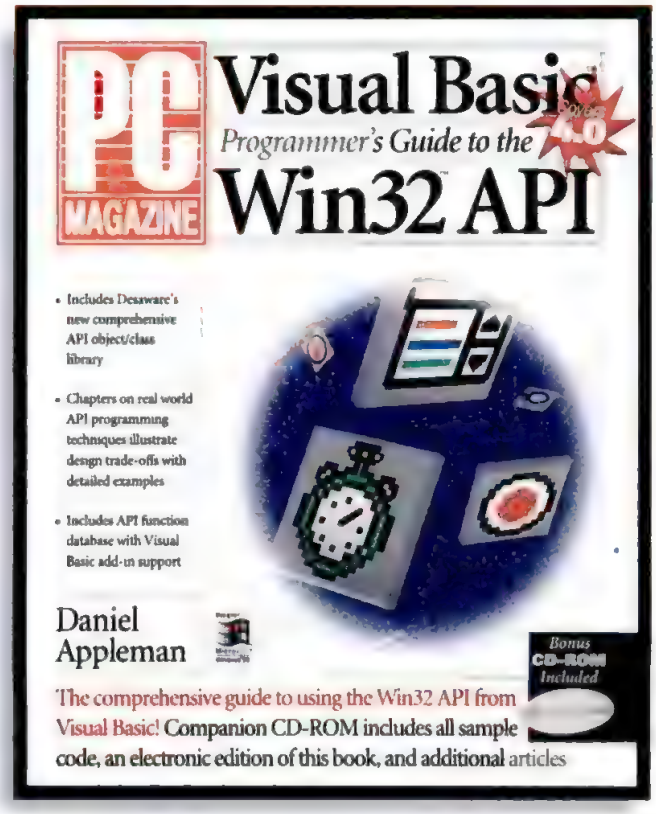

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ABOUT THE AUTHOR:

Daniel Appleman is the founder of Desaware, one of the leading vendors of Visual Basic add-on products including Spyworks and VersionStamper.

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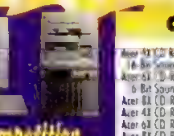

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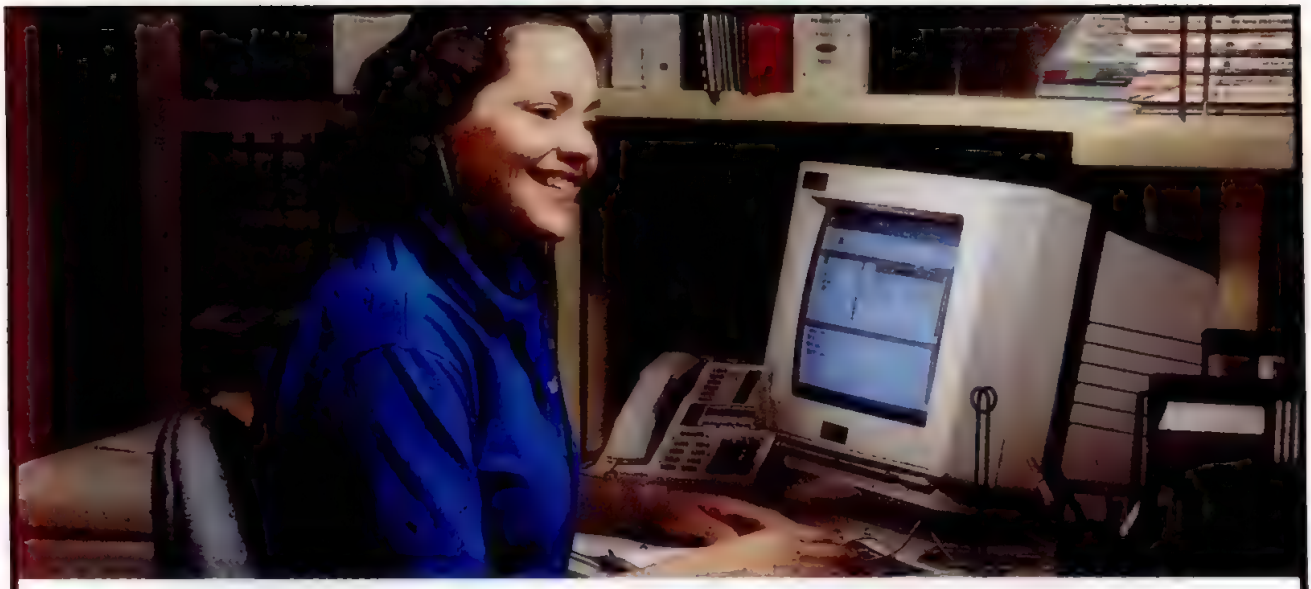

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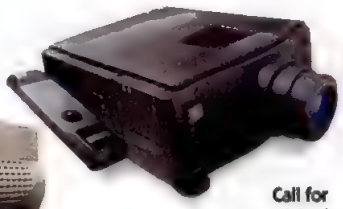

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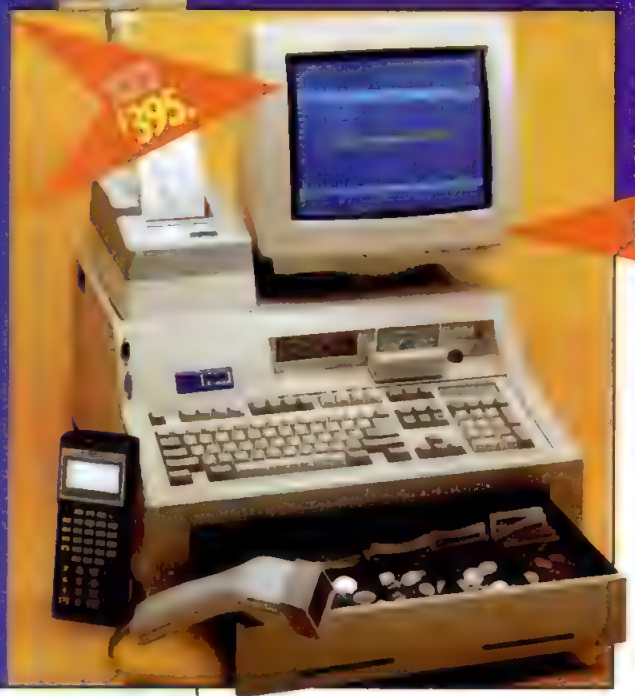

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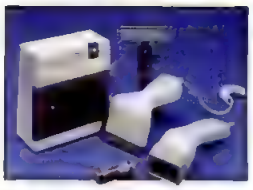

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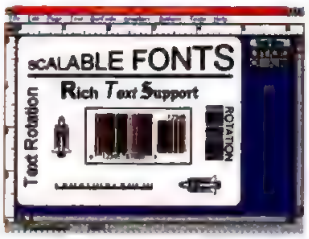

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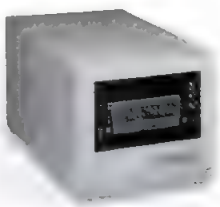

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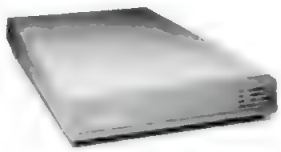

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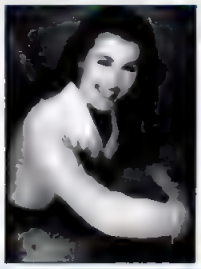

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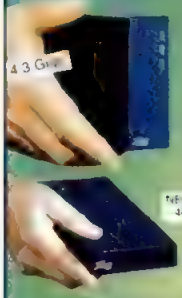

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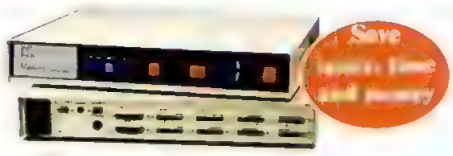

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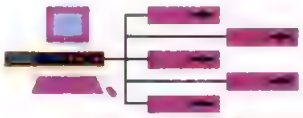

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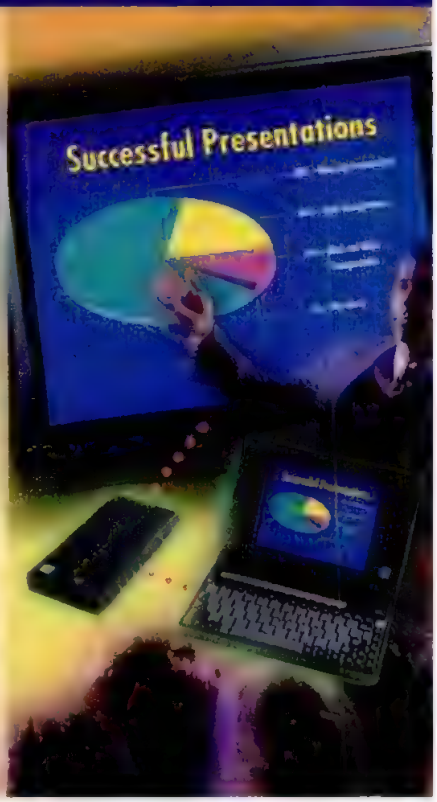

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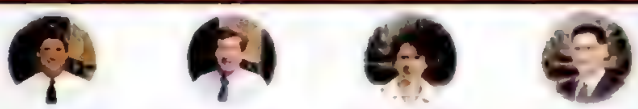

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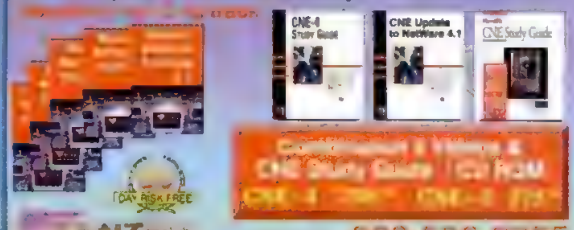

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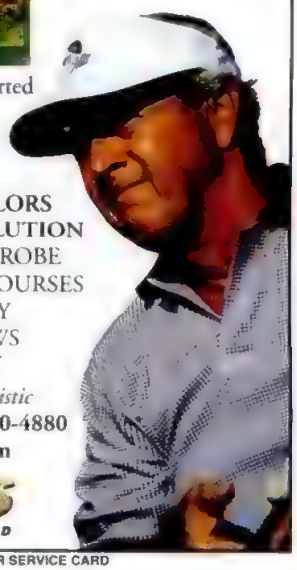

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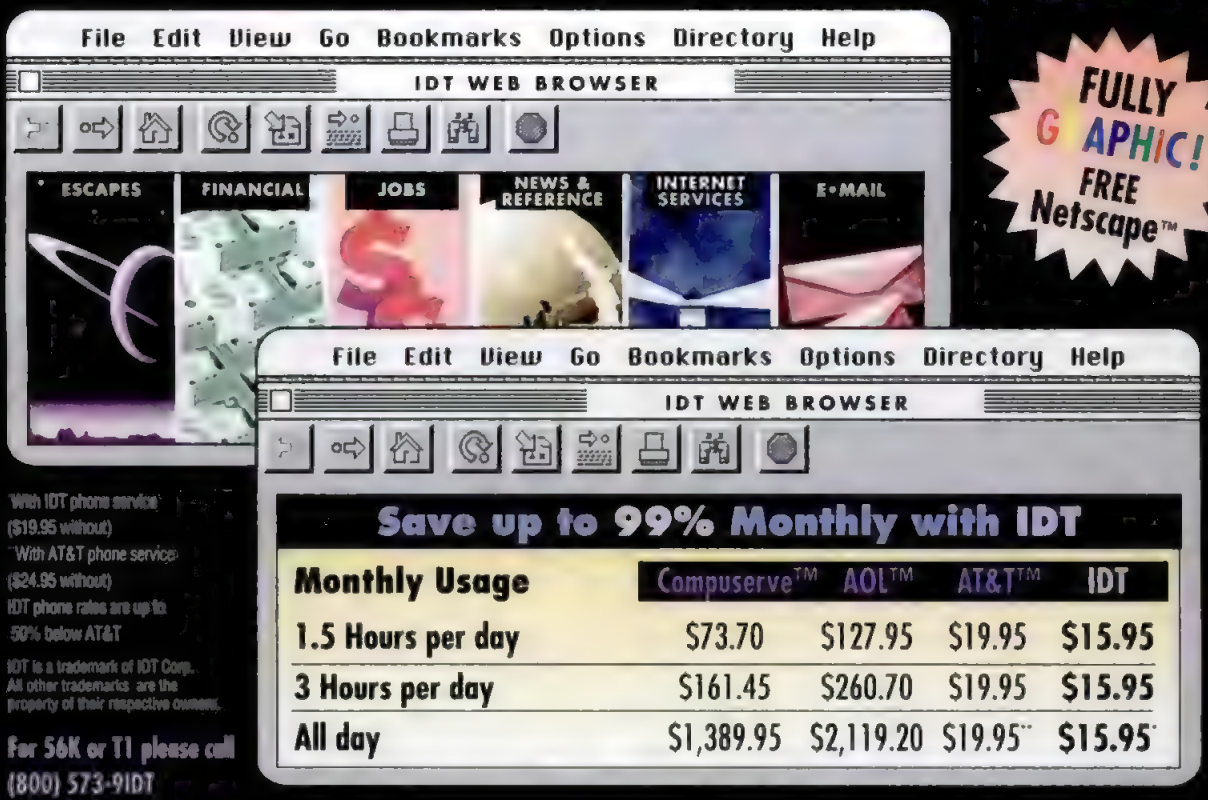

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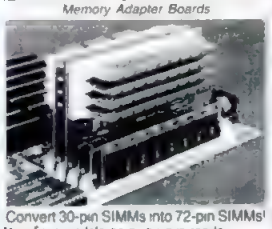

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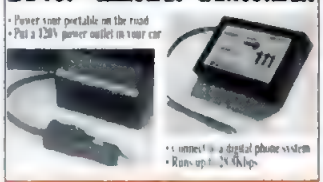

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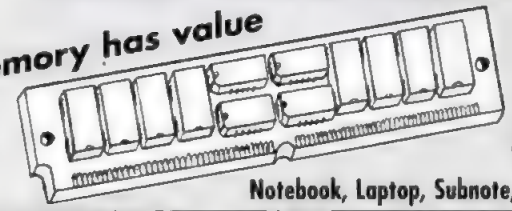

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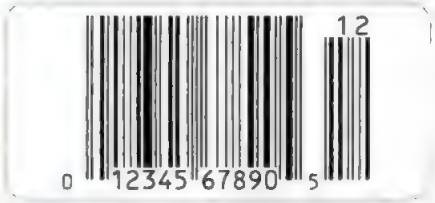

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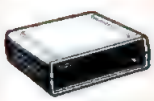

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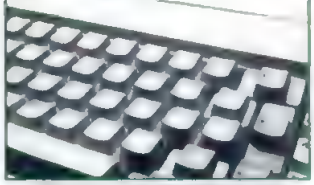

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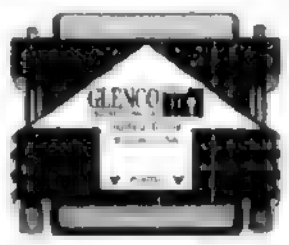

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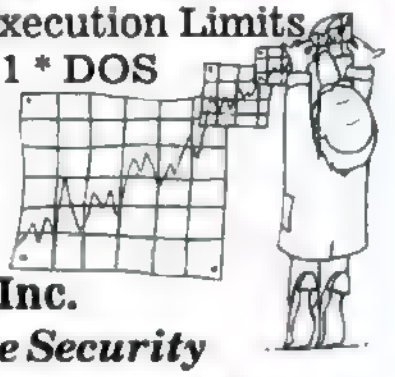

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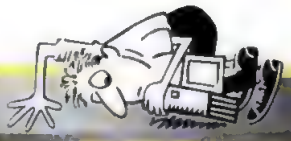

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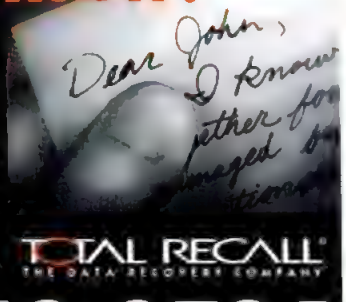

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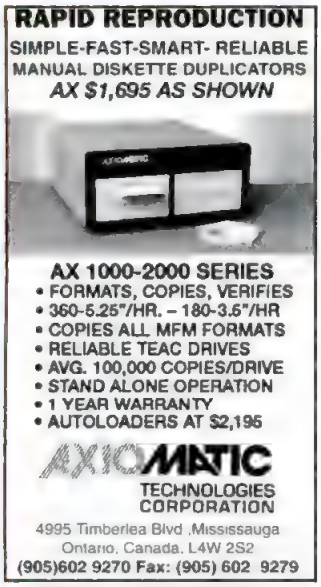

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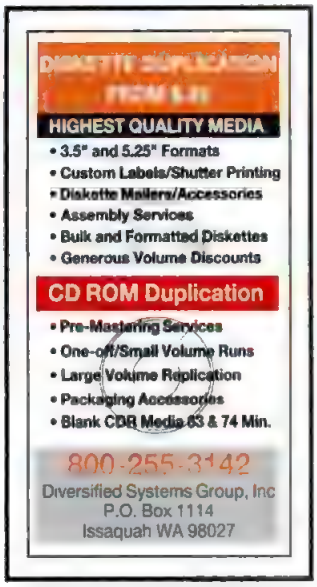

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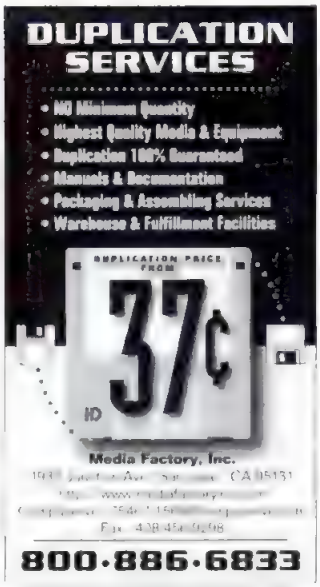

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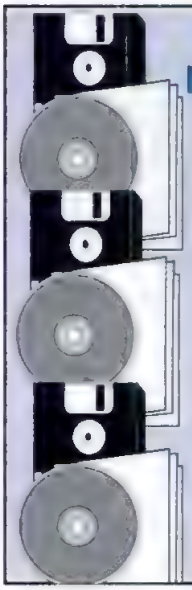

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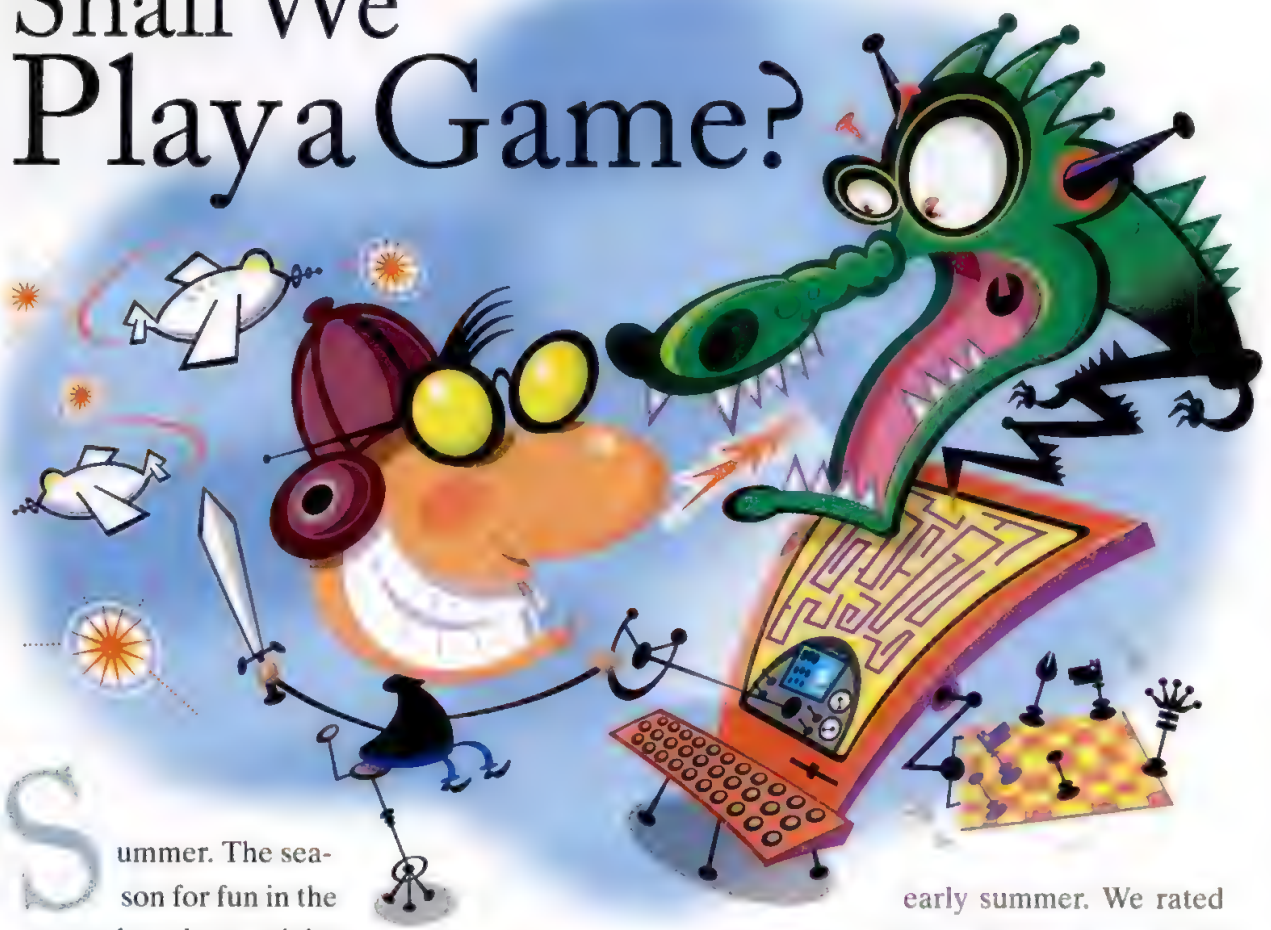

ILLUSTRATION BY WAYNE VINCENT

By Michael E. Ryan

Summer. The season for fun in the sun and outdoor activity. The last thing you want to do is stay glued to your PC for hours at a time, right? Well, don't answer that question just yet. Wait till you look over our summer games roundup. That's right, a roundup of 25 recently released PC games in four of the most popular categories: action, adventure, simulation, and strategy. The games you see here represent the best releases of the spring and early summer. We rated each on a four-star scale, with four stars being the best.

The games vary widely in style and theme, but we're sure that you'll find at least a few to your liking. One surprising note: Despite the hype of late 1995, most of the titles we received for inclusion in this story are DOS games. Many of those are compatible with Windows 95, but only a handful of the games reviewed here are Windows 95–specific.

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ACTION/ARCADE GAMES

Fast-Paced, Furious Fun for Action Fans

What qualifies as an action game? Basically, any game that places more emphasis on reaction time than it does on thought and strategy. Some people call them "high-twitch"; we just call them *fun*.

Duke Nukem 3D

★★★★

Aliens are stealing Earth women! The latest tabloid headline? Possibly, but it's also the plot for one of this year's hottest games: Duke Nukem 3D ($39.95 list, 3D Realms Entertainment, 800-276-4331). This DOS-based, first-person shoot-'em-up is heir apparent to the action-game throne that DOOM and DOOM II have occupied for so long.

First things first, however: We must warn you that Duke Nukem 3D is for adults only. The violence and gore you might expect from DOOM-style games are definitely here. In addition, portions of the game take place in a strip bar—complete with animated strippers—while in other spots, video screens depict near-pornographic animations and still others show the kidnapped women in various stages of undress. Also, many of the quips uttered by our hero contain profanity. The game does include a password-protected parental lock option that eliminates most of the adult material and language. Still, this is definitely not for kids, nor is it for anyone likely to be offended by the aforementioned situations.

After that kind of disclaimer, you may wonder why we would bother to review such a game. Simply put, Duke Nukem 3D is the best, most technically impressive first-person action game on the market right now. The game's 3-D engine is phenomenal, with each of the 28 levels rendered in Super VGA with amazing attention to detail. One of the early levels even has a working pool table, and further on you'll find a working subway and a sushi bar.

Realistic underwater movement is one of Duke Nukem's coolest features, and the game's internal scripts (similar to those employed by Raven's Hexen) bring many realistic events to life, such as an earthquake along the San Andreas Fault. Finally, the game's ten weapons are guaranteed to make any action fan drool—especially the laser trip mines and the awesome Devastator. You can even shrink your foes and squash them with your boot.

Multiplayer fans will love the eight-player network play option, which has already proven quite addictive in PC Labs (especially on the Stadium, Lunatic Fringe, and L.A. Rumble levels). The game even comes with its own level editor.

So if you're looking for the Next Big Thing in 3-D action games, look no further than Duke Nukem 3D. Just remember that you'll have to brave a barrage of offensive material in order to experience it. *Circle 442 on reader service card.* —*Michael E. Ryan*

Earthsiege 2

★★★

After the release of MechWarrior 2, it seemed future attempts at mech games would be a waste of time and money. But Sierra's Earthsiege 2 ($54.95 list, Sierra On-Line Inc., 800-757-7707) dispels such skepticism. Though it may not knock MW2 from the top spot in this genre, EarthSiege II will definitely hold its own.

In this Windows 95 sequel to the original EarthSiege, you are once again pitted against the Cybrids. These evil robots have assembled in massive numbers and are preparing an all-out assault on Earth. You must do battle with the Cybrids in your HERC (this game's equivalent of a mech) and salvage the technology gathered from those you destroy in order to continue the struggle.

The Super VGA graphics are at least as good as those in MechWarrior 2, with rolling hills, canyons, craters, and some of the best explosion graphics we've ever seen. And if you thought the jump jets in MechWarrior 2 were cool, EarthSiege 2 has a full-fledged flying HERC called the Razor to go along with its eight customizable ground HERCS.

The game includes more than 50 missions that range over many different landscapes. You need a fair amount of strategic smarts in order to use the terrain to your advantage and decide which weapons to use so as to maximize your salvaging possibilities.

Though we did encounter the occasional bug, we're sure that EarthSiege 2 will be the perfect solution for those disillusioned followers of the Jade Falcon clan looking for new mech challenges. *Circle 443 on reader service card. —Shane Mooney*

Cyberia² Resurrection

★★★

We liked the original Cyberia (reviewed in After Hours, April 11, 1995), so we expected a lot from Cyberia² Resurrection ($49.99 list, Virgin, 800-874-4607). We weren't disappointed.

Once again you are cast as Zak, ace hacker, in the twenty-first century. Having been awakened from a five-year cryogenic sleep by a group of rebels, you find yourself on the run and blasting bad guys before you can say "What's going on?" You quickly learn from your female liberator that your former employer has developed a lethal biological weapon that will soon be unleashed on the general population. But thanks to your last assignment, your bloodstream contains the antidote. You need to get to the secret laboratory, extract the antidote, and blow the weapon into the twenty-second century.

Cyberia² is very much an arcade game (for DOS), but it's one of the best-looking arcade games ever produced. The brilliant full-motion Super VGA graphics help bring Zak's predetermined path to life as you vaporize soldiers, enemy ships, and whatever else crosses your sights.

Though gaming purists may quickly tire of the repetitive action, fans of the Rebel Assault games will surely take to Cyberia². *Circle 444 on reader service card.—SM*

Heretic: Shadow of the Serpent Riders

★★★

One of the best games to implement the DOOM engine is back. Heretic: Shadow of the Serpent Riders ($34.95 list, GT Interactive, 800-610-4847) includes the original Heretic plus two new, nine-level episodes that will bring this first chapter of the Heretic/Hexen trilogy to a definitive close. The DOS-based title also includes two deathmatch-only levels.

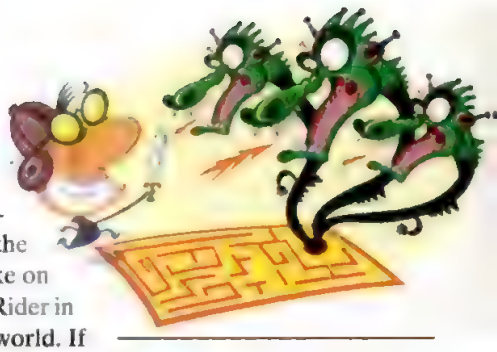
Otherwise, the fantasy-based game is the same as ever: You take on D'Sparil the Serpent Rider in an effort to save the world. If you're a registered Heretic owner, you can actually download the extra episodes for free. Otherwise, gamers looking for top-quality first-person action will want to pick up this CD-ROM. *Circle 445 on reader service card.—MER*

Whiplash

★★★

Whiplash is the perfect DOS-based game for anyone who's ever wanted to cut loose from rush-hour traffic.

Whiplash ($49.95 list, Interplay Productions, 800-468-3775) pits you against up to 15 computer racers on 16 different tracks filled with everything from cross-traffic jumps and multiple corkscrews to huge loops. You'll definitely be reaching for the Dramamine as you race toward the finish line in your choice of eight racing machines. *Circle 446 on reader service card.—SM*



Abuse

★★

In the age of DOOM and Crusader: No Remorse, only a handful of sideways-scrolling shoot-'em-up games are likely to impress the PC gaming crowd. Abuse ($39.95 list, Origin Systems, 800-245-4525) is not one of those titles.

The premise: You're a wrongly convicted inmate stuck in a prison where genetic experiments go awry. You have to fight your way past hordes of mutants while avoiding deadly traps. The execution is actually pretty slick, with nifty mouse controls and smooth animation. The mouse controls your aim, while the cursor keys control your movement and other actions.

Still, Abuse is not the sort of game you'd run out to buy. It's better purchased from the bargain bin. Luckily, you can download the shareware version before you plunk down your hard-earned bucks. Abuse runs under both DOS and Windows 95. *Circle 447 on reader service card.—Bernard H. Yee*

Big Red Racing

★★

Ladies and gentlemen, start your engines! Big Red Racing ($29.95 list, Domark Software, 415-513-8929) takes you around the world and beyond as you compete in some of the wackiest races that

Our Contributors: JOHN DELANEY is director of operations of PC Labs. SHANE MOONEY and BERNARD H. YEE are frequent contributors to *PC Magazine*. MICHAEL E. RYAN was the associate editor in charge of this story.

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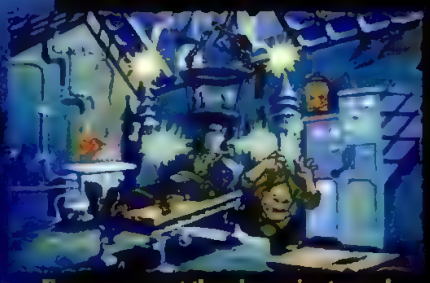

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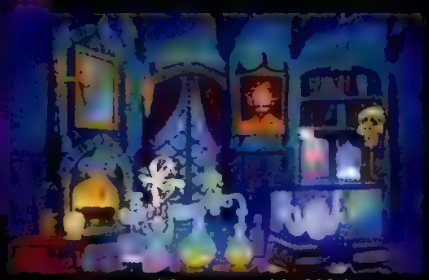
In Dracula's library there's no time to read!



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you're ever going to see.

At the start of each race, you get to choose one of six crazy characters. Then you're ready to choose one of the 24 tracks from around the world and even on Mars, Venus, and the moon. Finally, you get to choose a vehicle. You may find yourself in a helicopter, monster truck, hovercraft, or even a snowplow depending on where you're racing.

One thing we hated about the game was the incessant commentary that runs throughout each race, which was annoying and often unsuitable for younger ears. Fortunately, you can disable this feature.

While this DOS-based game is amusing at first in single-player mode, it gets boring in a hurry. But Big Red Racing can be a lot of fun in multiplayer mode (up to six can play over an IPX network, or two connected via modem or direct serial link). During our tests in PC Labs, each race was full of bad driving, ramming attempts, and fits of laughter. *Circle 448 on reader service card.—John Delaney*

Havoc

★★

Havoc is a first-person, demolition-derby racing game. Been there, done that? Maybe not, because Havoc ($69.99 list, Reality Bytes, 617-621-2500) offers multiplayer support for up to 16 players on both Macs and Windows 95 PCs. Havoc actually comes on two CD-ROMs, one a master disk and the other for one networked opponent.

The game play is simple, as you drive around in one of three vehicles and destroy buildings and opponents while accumulating power-ups on the neatly texture-mapped polygonal terrain. As a stand-alone game, Havoc can be downright dull, but over the network, this is uncomplicated fun. *Circle 449 on reader service card.—BHY*

Rayman

★★

Are you the type of gamer who longs for the carefree, innocent days of Super Mario Brothers? If so, we may have the perfect game for you. Ubi Soft's Rayman ($49.95 list, Ubi Soft Entertainment, 800-824-7638) is a delightfully twisted arcade game full of colorful graphics, funky sounds, and humorous creatures.

Rayman offers 70 levels of action, each of which is set against bizarre and surreal backdrops. You control our hero as he jumps, climbs, punches, and flies through the game. Along the way, you'll pick up new skills and run into bad guys who learn and even adapt to your playing style. Rayman runs on DOS, Windows 3.*x*, and Windows 95. *Circle 450 on reader service card.—MER*

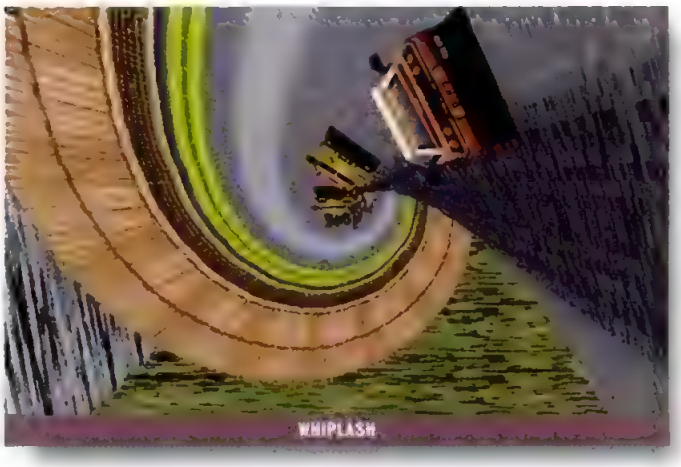
Savage

★★

Imagine combining Sanctuary Woods' Lion with id Software's DOOM and you'll have an idea of what Savage ($39.95 list, Discovery Channel Multimedia, 800-678-3343) is all about. This intriguing action game from Discovery Channel Multimedia puts you in the role of a lion cub.

In a 100-square-mile plot of the Serengeti, you must grow into lionhood and assume the role of leader of the pride. The graphics are decent, though they are a bit sluggish in the Super VGA modes on slower systems.

Savage is a truly novel attempt to liven up the first-person genre. Just don't expect the sanitary atmosphere of *The Lion King* here: In Savage, you're expected to bring down a gazelle or two in order to survive. Savage runs on Windows 3.*x* and Windows 95. *Circle 451 on reader service card.—BHY*



Coming Attractions: Quake

DOOM fans rejoice! The long-awaited next chapter in the DOOM series from id Software is at hand. While no one outside id really knows when this epic will ship, early glimpses at a "nonalpha, nonbeta network test version" of the game left most of us at PC Labs impressed. The entire graphics engine has been redesigned to provide even more detail and cooler lighting effects. And of course, Quake will offer multiplayer support for up to eight players.

We're quite sure that Quake will challenge Nukem 3D for the right to claim the action-game crown.—*MER*

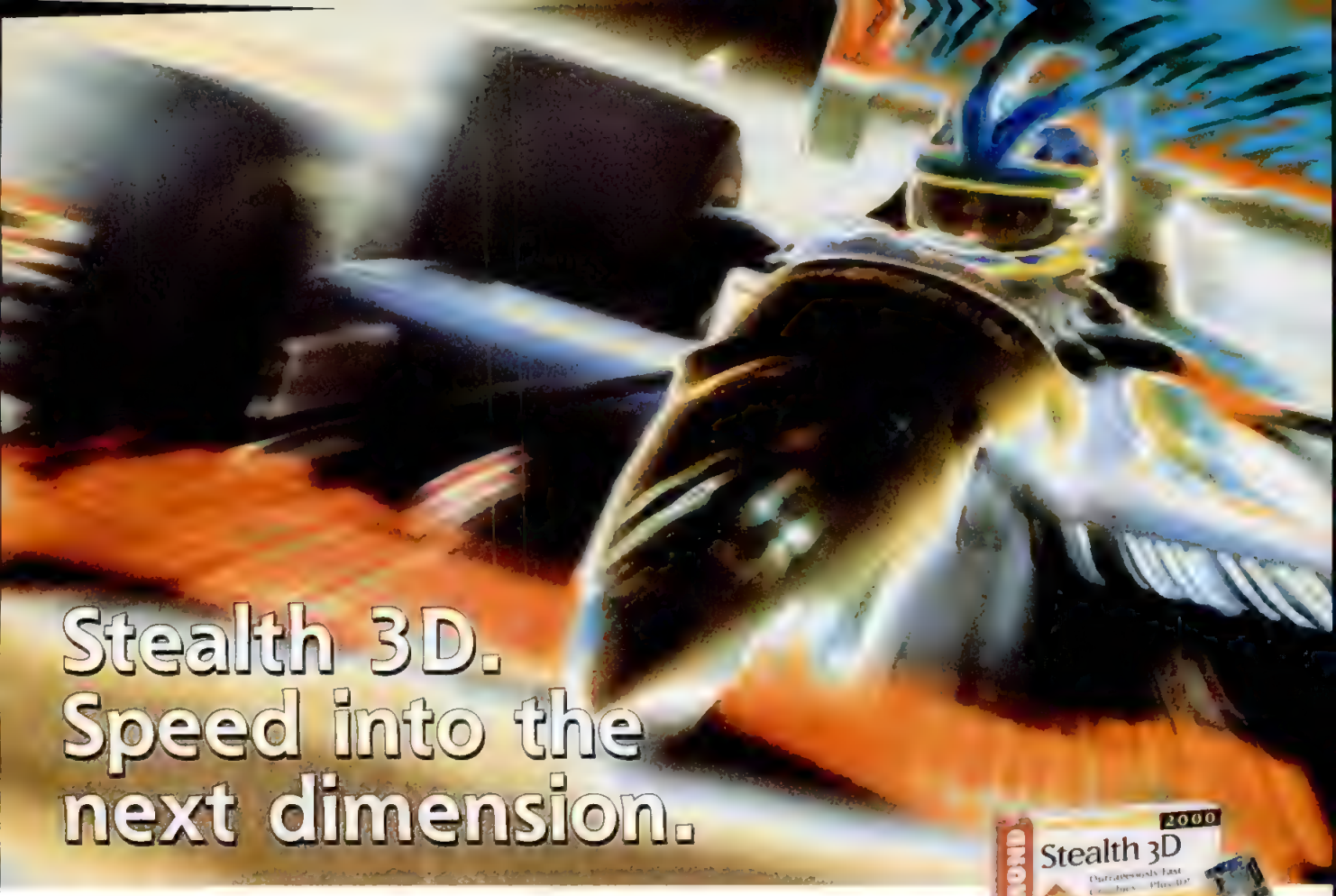
Terminator: Future Shock

★★

Terminator: Future Shock ($59.99 list, Bethesda Softworks, 800-677-0700) is a first-person action game set in the postapocalyptic Los Angeles depicted in *The Terminator*. You are one of the human resistance fighters who must combat the evil robots controlled by SkyNet.

The basic game play is like that of all other first-person shooters: Move fast, shoot faster. But the game uses an incredibly realistic 3-D engine that gives the action a wonderful sense of depth. The downside is an absurdly difficult control system that uses the mouse to aim and a myriad of other keys to move and perform other actions.

Besides the graphics engine, the game offers a 3-D automap that far surpasses all the others we've seen, along with some really impressive weapons effects. A multiplayer expansion pack for this DOS game was supposed to have shipped earlier in the year but was not available as this story went to press. *Circle 452 on reader service card.—MER*



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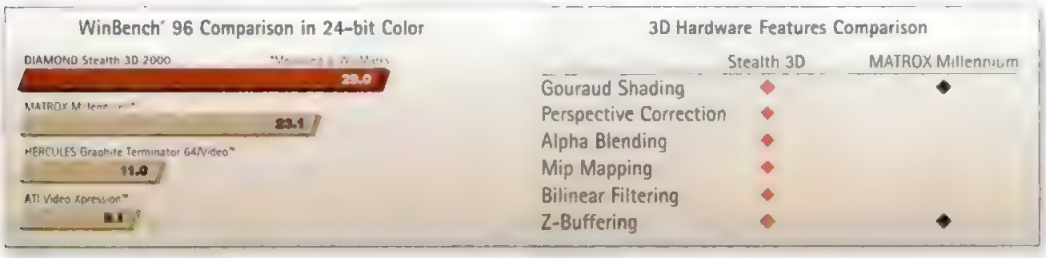

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ADVENTURE GAMES

Deep-Thinking Puzzlers for The Adventurous Gamer

Even before the advent of Myst, adventure games have traditionally been very popular. By placing you in a virtual world and challenging you with a number of complex puzzles, a good adventure game can hook even the most experienced game player for weeks.

Bad Mojo

★★★★

Roger Samms, an entomologist, is about to skip town with a briefcase full of ill-gotten money when he suddenly remembers an old family heirloom: the locket left for him by his mother. Rummaging through his desk, he finds the mysterious trinket and holds it up to the light. But then a strange feeling comes over Roger as he undergoes a metamorphosis that will forever change his view of the world. Roger has just been transformed into a cockroach.

Bad Mojo ($50 street, Pulse Entertainment, 310-264-5579) is a Windows (3.1 and 95) game that takes you on an amazing journey as seen through Roger the cockroach's eyes. The setting is Eddie's Bar on the Waterfront in San Francisco, an eating and drinking establishment that has seen better days. The idea is to make your way up from a sewer pipe in the basement of this dive to the different levels of the building. Along the way, you'll find clues about your real identity and hints as to how you can return to human form. But the path is laden with obstacles that threaten death or—even worse—prolonged life as a roach. You'll run into other insects as well as larger animals, humans, and a pair of basic elements (fire and water), but not all of these are your enemies. And you must investigate every nook and cranny to succeed.

Making excellent use of 256-color graphics, video clips, and eerie music and sound effects that are almost too realistic, the folks at Pulse Entertainment have put together one of the most intriguing adventure games yet. As bizarre and disturbing as Bad Mojo is, it is equally clever and intense, and will keep you playing for hours.

Because of its graphic nature, Bad Mojo is not for younger players. Even among adults, some scenes evoked screams from staff members at PC Labs and even a few roach nightmares. Now *that's* bad mojo. *Circle 453 on reader service card.—John Delaney*

Zork Nemesis

★★★★

Long before such modern luxuries as Windows and the mouse, there was Zork. The Zork games, even as text-only adventures, were so playable and compelling that many gamers still long for a game to equal their simple charm. At last the wait is over. With Zork Nemesis ($54.95 street, Activision, 800-477-3650), Activision has captured the flavor of the original series and brought it to life with immersive graphics, sound, and animation.

You find yourself trapped in a courtyard, with nowhere to go but inside the temple you see before you. You discover that an entity known only as Nemesis has trapped four alchemists and sentenced them to die. To free them, you must solve the dozens of complex puzzles that lie before you. But in doing so you begin to learn the true nature of the evil at work and you must make moral decisions that will greatly affect the outcome of this three-CD title.

Zork gives you full 360-degree rotational movement in a beautiful 3-D–rendered environment. As in most adventure games, you wander through the various locales, searching for clues and important items to help you in your quest.

The 3-D sounds pan from speaker to speaker as you move through the game. Haunting music adds a gothic tone, and the graphics easily surpass those of the countless Myst clones on the market (and perhaps of Myst itself).

The only downside is that the game doesn't play full-screen. It fills only about 75 percent of the screen, similar to the letter-box version of a movie as seen on TV. So those with 14-inch monitors may be frustrated by the view. But even with that minor annoyance, this is still one of the best adventure games around. *Circle 454 on reader service card. —Shane Mooney*

Spycraft: The Great Game

★★★

The world of spies always seems so glamorous in the movies. But even though most of us don't have what it takes to be a real-life James Bond, we can live the adventure vicariously through Activision's Spycraft: The Great Game ($49.95 list, Activision,

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The Child Care CD is a resource guide for child care center directors and caregivers that can be used for daily reference, information sharing and professional development. It is also designed for use by early childhood education instructors and students, physicians, public health professionals and others. This CD-ROM will assist child care professionals in their day-to-day work by answering health-related questions and providing current medical information. It can also serve as a tool to evaluate health policies as they are put into practice.

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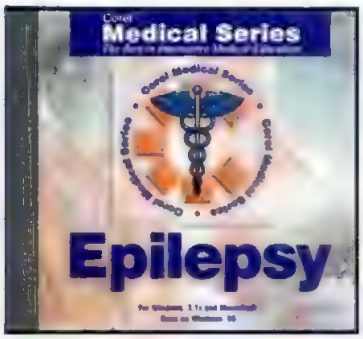

$49*

Epilepsy

The Epilepsy title provides a wealth of up-to-date information on this rapidly expanding area of medical research and offers in-depth analysis of all aspects of epilepsy. This CD-ROM is an invaluable resource for medical students, physicians, neurology and psychiatry residents, nurses and especially patients and their families.

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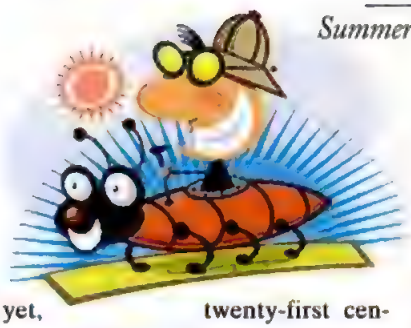


800-477-3650).

Someone has assassinated a high-ranking political figure in the former Soviet Union, and after a little digging you find out that Americans are involved. Worse yet, the assassin may be a former CIA operative who has managed to gain access to top-secret weapons. You must piece together the clues and track down the forces that threaten international peace and even the life of your own president.

This three-CD title was produced with help from the late former CIA director William Colby and his former foe, KGB Major General Oleg Kalugin. Colby even makes a cameo appearance in the game.

During the game (which runs on DOS and Windows 95), you'll have to listen in on phone conversations, watch spy cameras carefully, and find that little sound, image, or other piece of information that can help track down the bad guys. You'll also have to calculate bullet trajectories, examine satellite imagery, and even handle a gun for a few action sequences.

Combine all this with full-motion video, Super VGA graphics, and overall high production values and you've got quite a game on your hands. In fact, if you've always wanted to be a spy, then Spycraft is will absorb you faster than you can say "Bond, James Bond." *Circle 455 on reader service card.—SM*

Angel Devoid

★★

Imagine waking up in a hospital with a face that has been surgically reconstructed to look like that of your worst enemy. This is the premise of Angel Devoid ($50 street, Mindscape, 800-234-3088), a police adventure set in a Blade Runner–esque twenty-first century. Angel wants to deliver a true interactive movie experience, but unlike most of its predecessors in the category, this title pulls off the stunt, with high production values and tons of full-motion video.

You play the role of Jake Hard, the stereotypical cynical cop with an honest heart, who must survive with his enemy's identity until he can bring the real Angel to justice.

Game play is unlike most adventure games in that you do not choose exactly what you say to the various characters you meet. Instead, you choose a mood, such as "aggressive" or "passive."

Unfortunately, the game involves a lot of trial and error as you attempt to make the decision that won't get you killed. But all things considered, Angel Devoid is fun and proves there may be hope for interactive movies after all. *Circle 456 on reader service card.—SM*

D

★★

You always thought your father was a bit odd, but you never thought he would take over his own hospital and slaughter countless innocents—which is exactly what he's done. The Los Angeles police are helpless, so they reluctantly decide to let you, Laura Harris, into the hospital to try to find out what sent your father over the edge.

On entering the hospital, you step your way through the carnage as you try to find your father. Suddenly you find yourself whisked away to a strange, gothic mansion filled with bizarre puzzles and potentially lethal traps that is somehow a manifestation of your father's twisted mind. The image of dear old Dad appears intermittently to warn you to go back before it's too late, and you realize that unless you solve the mystery in 2 hours or less, you'll be doomed as well.

This is D ($54.95 list, Acclaim Entertainment, 516-759-7800), a DOS-based graphic adventure full of horror and suspense. The game utilizes 3-D–rendered graphics exclusively and a minimal interface.

This is not a game for the squeamish. You'll find yourself having to wade through cadavers and even rifle through their belongings. But hard-core gamers might be even more horrified by one of the game's basic elements: If you don't complete the entire game in 2 hours, it ends and you have to start over.

But if you don't mind the time limit or the grisly theme, you may want to grab a bucket of popcorn, turn off all the lights, and load up D. *Circle 457 on reader service card.—SM*

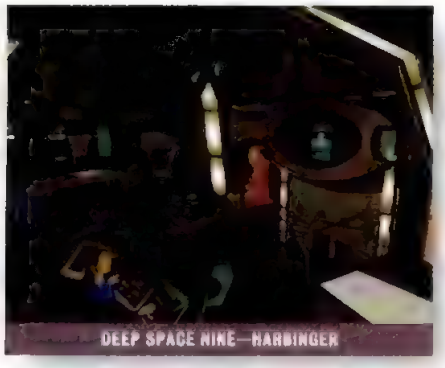
Coming Attractions: Nemesis: A Wizardry Adventure

The Wizardry games constitute one of the most popular and well-designed role-playing series ever produced. Come this fall, Sir-Tech hopes to keep that tradition alive with Nemesis: A Wizardry Adventure (not to be confused with Activision's latest Zork game). This game features a blend of adventure and role-playing elements, all set against dazzling rendered scenery. Nemesis is scheduled to ship in September.—MER

Shannara

★★

If you've ever read Terry Brooks's classic fantasy book *The Sword of Shannara,* you know that the



Star Trek: Deep Space Nine—Harbinger

★★

Like the television show on which it is based, Star Trek: Deep Space Nine—Harbinger ($54.99 list, Viacom New Media, 800-469-2539) is a less-than-thrilling adventure. This is not to say the game is bad: It does reproduce the feel of the show, down to an accurate and detailed layout of the space station. But the story is only fair and the puzzles unchallenging.

You play a Tirrion envoy of the elite Federation Diplomatic Corps on a mission to Deep Space Nine. But your ship is attacked en route and you soon discover that the ships behind the assault are part of a larger plot. You must now help track down a murderer on the station and match wits with the alien race bent on annihilating Deep Space Nine and an entire Gamma Quadrant race.

Despite the good graphics and voice acting (performed by actors from the TV series), the game lacks compelling game play and interesting twists. Also, you don't have much say in the direction of the story, even in dialog. Instead of controlling the path of the game with what you say, you simply decide in which order questions are asked.

Still, this DOS game is true to the television series and should appeal to "Star Trek" fans. *Circle 459 on reader service card.—SM*

sword in the title was used to defeat the evil wizard, Brona. But in the true spirit of sequels, we find in the DOS-based game Shannara ($59.95 list, Legend Entertainment Co., 800-658-8891) that Brona wasn't *quite* vanquished. In fact, the sword has been shattered, so you have to find and piece together the sundered artifact.

As Jak, you must journey to the alien lands of the Dwarves, Gnomes, Elves, and Trolls. In each place, your mission is to find a magic item and ask a special someone from each of these groups to help you repair the shattered sword.

The graphics in Shannara are attractive enough and the puzzles sufficiently friendly that adventure novices won't be ripping their hair out trying to finish the game. Die-hard adventure gamers, on the other hand, may be turned off by the relatively simple game play and might want to look elsewhere.

Nevertheless, Shannara provides a pleasant way to spend an afternoon, and it does a nice job of bringing a classic fantasy world to life. *Circle 458 on reader service card.—SM*

FEATURES PLUS

From July 1 to 5, discuss games and gaming with *PC Magazine* associate editor Michael Ryan and some of the game developers mentioned here. Just go to our Web site (*http://www.pcmag.com*) and select Discuss on the navigation bar.

SIMULATIONS

Sail the Hostile Seas and Fly The Unfriendly Skies

Any game that recreates a real-life event or situation is generally referred to as a simulation. The most popular of these games are flight simulations, but sims can also recreate driving around a track at 200 miles per hour, sailing over the waves, or even lurking beneath them.

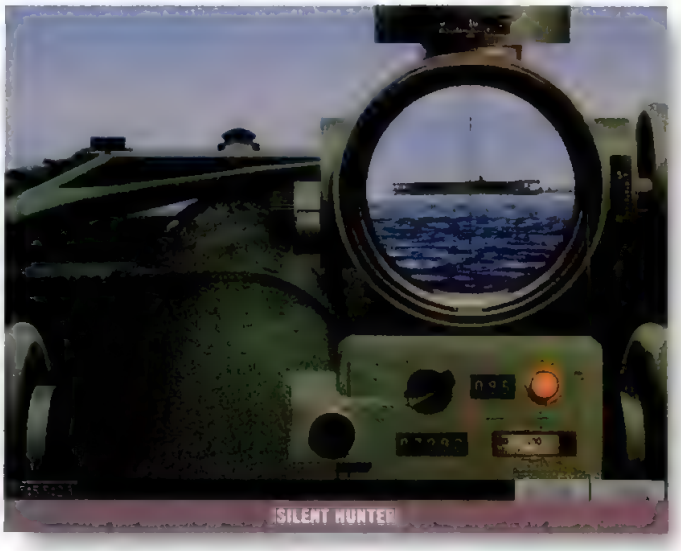
Silent Hunter

★★★★

From the classic Silent Service to the popular Aces of the Deep, submarine simulations have always been popular among gamers. The latest sub game, Silent Hunter ($50 street, Strategic Simulations Inc. [SSI], 800-601-7529), looks as though it will continue the tradition.

This DOS-based game puts you in command of an American sub in the Pacific during World War II. Your goal: to sink as much Japanese shipping as possible during your "career." During the game, you embark on a series of war patrols in various regions of the Pacific. Starting in 1941, for example, you take your boat out of Manila Bay in the Philippines and begin your hunt for enemy shipping. As you progress, the game tracks the number of ships you sink and the total tonnage of those ships (which is more important). The big prizes are the carriers and battleships, but you'll probably run into a greater number of small destroyers and transport ships.

Depending on your record, you may receive medals and letters of commendation—although neither award is particularly difficult to get. For example, we played on the game's highest difficulty setting and racked up over 300,000 tons of enemy ship-



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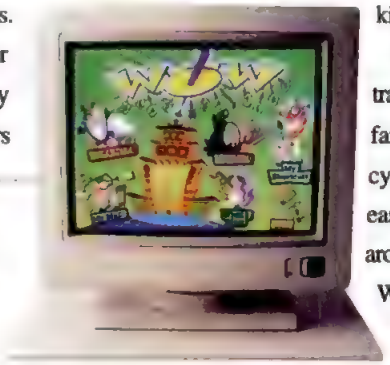

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ping in just six war patrols. During those patrols, we received a Bronze Star, two Silver Stars, two Navy Crosses, and the Congressional Medal of Honor—all by the middle of 1942. But we like awards, so we didn't mind.

We did notice that it was relatively easy to chalk up a lot of tonnage by lurking right outside an enemy harbor. Every time we destroyed a convoy at anchor near a port, the entire convoy would regenerate a few hours later (which was really only a few seconds later, thanks to the game's time acceleration option).

If you'd rather forgo the career path, you can still take your boat out for a single mission. For each mission, you can select the type of weather, the sea conditions, and the types of enemy vessels you will encounter.

No matter how you decide to play the game, though, you're likely to be impressed. The Super VGA graphics are good and the action is tense, reminiscent of such films as *Run Silent, Run Deep* and *Das Boot.* Also, novice gamers may appreciate the game's approachability and customizable realism settings.

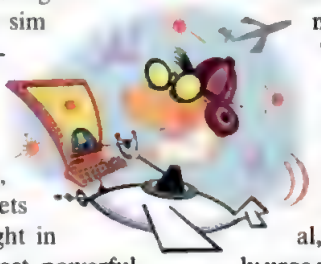
Finally, Silent Hunter includes a series of video interviews with retired sub commander William "Bud" Gruner, who narrates a tour of the submarine and recounts some of his wartime experiences.

With this historical perspective and the tension-filled action of its war patrols, Silent Hunter takes its rightful place in the long line of solid sub sims. *Circle 460 on reader service card.—MER*

ATF: Advanced Tactical Fighters

★★★

Remember the good old days, when an F-15 flight simulation was state-of-the-art? Well, those days are gone, but that's good news for flight sim fans. ATF: Advanced Tactical Fighters ($59.95 list, Electronic Arts, 800-245-4525) lets you fly and fight in the newest, most powerful types of military aircraft in the world—most of which exist only as prototypes.



Developed in conjunction with Jane's Information Group, the well-known publisher of reference books on military hardware of all kinds, ATF is the first product in the new Jane's Combat Simulations line from Electronic Arts.

Fans of EA's U.S. Navy Fighters will instantly recognize that product's influence on ATF. Everything—from the opening sequence, basic interface, and music to the excellent Super VGA graphics engine—is based on its U.S. Navy Fighters predecessor. And like U.S. Navy Fighters, ATF is a DOS-only game.

In ATF, you get to fly some of the world's most advanced aircraft, including the Lockheed-Martin/Boeing F-22, the Dassault Rafale C, and the Northrop Grumman X-29 FSW (which is the coolest looking of the bunch). You can also fly the stealth fighter (F-117A Nighthawk) and bomber (B-2A Spirit), but with all these other toys to choose from, the stealth planes seem almost passé.

Of course, with new aircraft comes some new technology. And although the game plays just like any other flight sim, the controls for each jet are different from what you're used to. The F-22, for example, has the ability to vector its thrust. In other words, you can point the nose up to face an enemy while still moving forward. This is not an easy feature to master, and it's the main reason for the game's inch-thick manual, which we strongly urge you to read.

When you do take off in your plane of choice, you have a number of game-play options. You can attempt to complete either of the two campaigns in the game (one in Egypt, one in Russia), each of which comprises 40 missions. You can also fly a single mission, which you can generate using either the powerful Pro Mission Builder editor, or the simple Quick Mission feature. Finally, you can try your hand at one of more than 30 predesigned missions for both single and multiple players (the game supports up to eight players on an IPX network or two players connected via modem or direct serial link).

ATF also offers plenty of photographs, technical specifications, and video clips of these cutting-edge aircraft. These multimedia goodies come courtesy of Jane's Information Group.

The only thing we didn't like about ATF was the game's complexity. While hard-core flight sim buffs may not even flinch at the learning curve involved, we found it extraordinarily difficult to complete the first mission in either campaign without cheating. Once we got the hang of thrust vectoring and other cool tricks, we fared much better. *Circle 461 on reader service card.—MER*

EF2000

★★★

For even more cutting-edge flight sim action, take a look at EF2000 ($47.95 list, GTE Entertainment, 800-483-8632). This ambitious title puts you in the cockpit of yet another twenty-first-century fighter, the Eurofighter 2000, which is being jointly developed in real life by the United Kingdom, France, Germany, Italy, and Spain.

This DOS-based game features beautiful Super VGA graphics that are even smoother and more impressive than those in ATF. EF2000 is also impressive behind the scenes: The game employs an incredibly intricate campaign-generation engine, called WarGen, that dynami-

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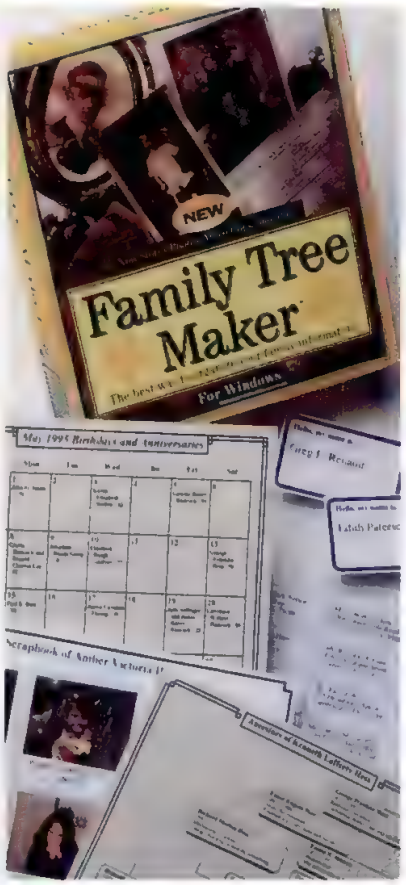

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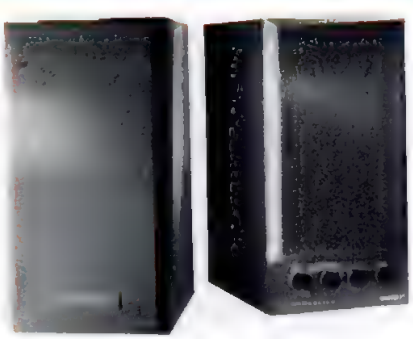

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Coming Attractions: AH-64D Longbow

In the second release under the Jane's Combat Simulations series, Electronic Arts is hard at work on AH-64D Longbow. This helicopter simulation (which is scheduled to ship in June) is under the guidance of Andy Hollis—who brought us such classics as Gunship and F-15 Strike Eagle—and will feature over 50 missions in the Baltic, Panama, and the Persian Gulf.—*MER*

cally creates a full-blown war in which your fighter plays a minor role. As you take off on a mission, you see other craft heading off on different assignments. The campaign unfolds differently each time you start over.

Although not quite as difficult to fly as the aircraft in ATF, EF2000 comes with its own learning curve (and correspondingly thick manual). The biggest problem is the cockpit display, which is difficult to understand without constantly referring to the manual. And it takes a while to master the art of looking "down" at the instruments and then back "up" (sounds easy, but it can be confusing).

Again, we urge you to read the manual thoroughly. Otherwise, you may find yourself stuck taxiing around the runway or (even worse) hopelessly lost in the air.

Still, with top-notch graphics and unsurpassed realism, this may be the game that jaded Falcon fans have been waiting for. EF2000 even offers multiplayer support, but only over an IPX network (up to eight can play). *Circle 462 on reader service card.—MER*

Silent Thunder: A-10 Tank Killer 2

★★

The original A-10 Tank Killer was a classic. Now Sierra has spruced it up with Super VGA graphics and moved it into the Windows 95–only realm to create the sequel, Silent Thunder: A-10 Tank Killer 2 ($59.95 street, Sierra On-Line, 800-757-7707).

Like Sierra's re-release of Aces of the Deep, Silent Thunder is designed to appeal to both flight sim purists and the more casual, action-oriented crowd. Customization features, such as the simplified flight model, make Silent Thunder approachable for novice gamers. The game includes a trio of hypothetical campaigns, each based on a world hot spot.

Silent Thunder looks fabulous in Super VGA mode, with texture-mapped terrain and detailed vehicle graphics, but you'll want a speedy Pentium—preferably one running at 133 MHz—to get this game going. But with the right system, Silent Thunder can provide a thrilling ride. *Circle 463 on reader service card.—BHY*

STRATEGY GAMES

Same Thing We Do Every Night: Try to Take Over the World

Strategy games stress the power of planning and preparation. From "god" games like Sid Meier's Civilization to real-time fight fests like Warcraft II, strategy games require plenty of thought and usually wind up costing you hours of sleep because of their addictive nature.

Conquest of the New World

★★★★

Ever wonder what it was like to sail over the mysterious horizon and reach new, undiscovered lands? In Conquest of the New World ($49.95 list, Interplay Productions, 800-468-3775), you get the chance to do just that. This epic game of fifteenth-century exploration and conquest pits you against up to five other players as you attempt to carve out a slice of the new world for your country. You can play the role of England, France, Holland, Portugal, Spain, or—in a welcome twist—Native Americans.

Conquest is a wonderful title full of innovative features. This turn-based DOS game offers several basic scenarios, but the goal is usually the same: to outlast or outcolonize your rivals. You begin with a ship of explorers and soldiers who must scout out a suitable location for the colony ship that follows close behind.

Once you establish your colony, you must build housing, mills, churches, forts, and other structures to keep it growing. As you run into native tribes and other colonies, you will have to decide how to treat them (and then live with those decisions). Relations with other European powers are largely dictated by your

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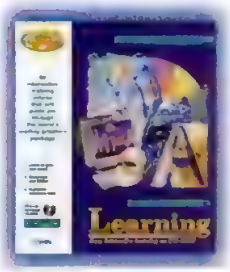

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mother country's relations with them, but you can always declare independence and forge your own relationships (although we don't recommend such a step unless you have a *very* powerful army).

Combat is unlike what you'll find in most other strategy games. It takes place on a small grid—almost like a high-stakes chess game full of infantry, cavalry, and artillery.

Graphically, the game is stunning: Just about everything on the screen, including the ships, rivers, villagers, and campfires, is highly detailed and even animated. From your skewed, overhead point of view, you can watch your colony grow and (hopefully) thrive.

Conquest offers solid multiplayer support for up to six players over an IPX network, or two connected via modem or direct serial link.

The one problem we encountered was that the game occasionally slowed to a crawl as we plotted our turn—even using a 166-MHz Pentium with 16MB of RAM. The delays were sporadic but maddening.

Otherwise, Conquest of the New World is a classic in the making and a genuinely enjoyable strategy game. *Circle 464 on reader service card.—MER*

Fantasy General

★★★★

The third installment of SSI's Five-Star series, Fantasy General ($45 street, Strategic Simulations Inc., 800-601-7529) is a turn-based war game with a sword-and-sorcery theme. Based on the same engine as the now-classic Panzer General, Fantasy General offers excellent graphics, challenging game play, and a rather addictive campaign mode.

You begin this DOS-based game as one of four warlords seeking to overthrow the oppressive Shadowlord with your army. Each warlord starts with a different army and different skills.

To move through the game, you must defeat the Shadowlord's forces in a series of set-piece battles on a variety of landscapes. As your victories mount, you can purchase new units for your army and upgrade others as you discover new technologies. During battles, you'll also find magic items and even some army volunteers.

Finally, on top of great graphics and excellent game play, Fantasy General includes one of the most outstanding musical scores we've ever heard in a PC game.

While it may not achieve the same classic status as Panzer General, Fantasy General is a well-rounded, challenging game that should appeal to many strategy-minded fantasy fans. *Circle 465 on reader service card.—MER*

The Rise & Rule of Ancient Empires

★★★

As a classic-style god game, The Rise & Rule of Ancient Empires ($54.95 street, Sierra On-Line, 800-757-7707) has a lot to offer: spectacular graphics, an intricate diplomatic model, and strong multiplayer support.

In this Windows (3.*x* or 95) game, you take charge of one of six empires (Chinese, Egyptian, Greek, Indian, Persian, or Visigoth) and try to lead it to glory. In traditional fashion, you found a city, improve it with things like a marketplace and city walls, then expand and found more cites. Along the way, of course, you will have to fight or befriend your neighbors.

The game offers some nice features, such as multiple modes of diplomatic communication between empires and the ability to "stack" military units. Rise & Rule also uses impressive Super VGA graphics and animations. The game shines in multiplayer mode (up to four can play on an IPX network, or two connected via modem), as you can finish a complete game in just two hours—an unheard-of feat for most other multiplayer god games.

One complaint we had was with the game's urban improvement options. We often found ourselves presented with far too many options to handle one at a time. We also feel that the game lacks that addictive quality that keeps us going back to Civilization II.

Still, Rise & Rule is a solid game that should interest multiplayer strategy fans. □ *Circle 466 on reader service card.—MER*

Coming Attractions: Deadlock

There are plenty of good strategy games on the way, but keep your eyes out for Accolade's Deadlock. In this space-based game of planetary colonization—which looked to us like a cross between Civilization and M.U.L.E.—you're competing against other players for control of an entire planet. But you don't have to conquer them; you just have to be the first to spread over the most territory and prosper. Strong online play will make this one a winner (so will the cool animated taunt feature). Deadlock should be out by the time you read this.—*MER*

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Figure 1: Multiple Outlets Leave PC Vulnerable to Voltage Differential

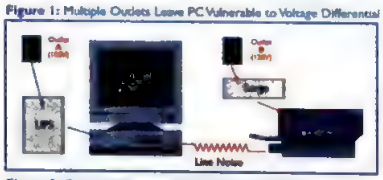
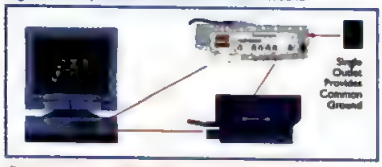


Figure 2: Computer Protected With Common Ground



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PC MAGAZINE

Coming Up

Notebook Blockbuster

Big brilliant screens, lighter travel weights, and modular designs are just a few of the features you'll find in this summer's new crop of Pentium-class notebooks. In this roundup of portables, we'll look at everything from sub-5-pound lightweight systems and value notebooks for the cost-conscious to fully loaded, 133-MHz desktop-replacement machines with 6X CD-ROM drives. PC Magazine Labs tests 59 notebooks from 34 vendors and puts them through their paces using its core set of benchmark tests as well as the new BatteryMark measure of system battery life. This issue also features a special pullout guide to computing on the road, with tips and tricks to make your travel easier.

The 25 Best Portable Peripherals

Picking the portable computer that best fits your needs and budget is the hard part. Now comes the fun: outfitting your movable office with the right peripherals. We review the new crop of combination PC Card devices that deliver both a 28.8-Kbps fax modem and a ready Ethernet connection. We also survey the field of other PC Card peripherals to find the ones that will make your portable PC more productive. Improvements are showing up in a wide array of larger peripherals, too. Printing on the road is getting easier—witness four lightweight wonders that let you print a little or a lot. If presentations are your province, check out five portable LCD projection systems that help you get your point across. We test the best compact CD-ROM drives and speaker systems—and even look at a range of bags and totes so that you can move your gear from point A to point B.

Remote-Control Software

Remote-control packages are getting better every time we review them. This year's crop includes the first native Windows NT Workstation products; they feature tighter Windows 95 integration plus better file-transfer and remote-control performance. We review seven remote-control software products that let you control a PC over a dial-up modem connection, a network connection, or even the Internet. We also look at OS/2 remote-control software, trends in remote-node networking, and other remote-access solutions.

Back to School

Before you know it, it will be time for the kids to go back to school. To help them ease back into the groove, we've reached into the vast educational software market and pulled out 50 solid titles that can help students of all ages get the most out of their classes during the coming year. We also highlight some musical instruction software and a selection of educational Web sites.

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ENDS

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Abort, Retry, Fail?

THE LIGHTER SIDE OF PERSONAL COMPUTING

By Don Willmott

Get Rich Quick! Sell Compasses in Utah

Here's how Dun & Bradstreet directed attendees to a Salt Lake City database seminar: "Find West Temple St. West Temple runs North-South and is placed one block West of Main St. Once you are on West Temple St., drive North or South all the way to 500 South and turn North towards the West. You should be exactly in front of the Hilton Salt Lake City."

Heck, I'll Take Two, and Put 'Em on My Visa Card!

"Two years ago, Novell Inc. paid $855 for WordPerfect and made it a separate division. Last week, Corel Corp. paid Novell approximately one quarter that amount for WordPerfect." —*WASHINGTON TECHNOLOGY*

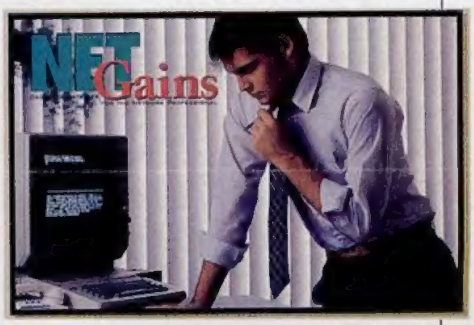
Dataquest sees broken home-PC market

"Jessica, Daddy and I are getting a divorce, but don't cry, honey. We're buying you a new computer." (*Electronic Engineering Times.*)

Hmmm. This could lead to massive layoffs at Compaq. (Oakdale, California, *Leader.*)

Ag forum to look at computer breeding

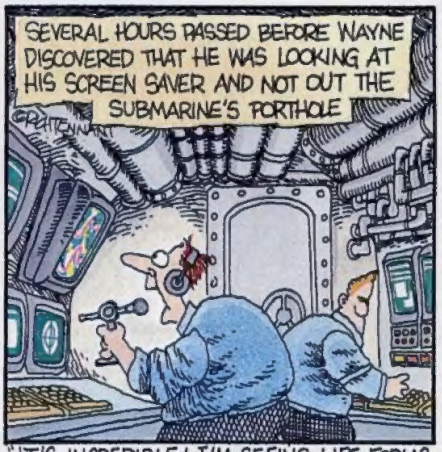
Imagine computer technology that maximizes ranchers' profits by taking some of the guesswork out of selecting



NETGains, the newsletter for high-tech career climbers who specialize in the Apple II, circa 1979.

Overheard

"The paperless office is about as likely as the paperless bathroom." —Anonymous on CompuServe's DTP forum.



EZDrive vs ZIP

Feature	EZDrive	Zip
Drive	135MB	100MB
CAPACITY	13.5ms	29ms
SEEK TIME	2.4MB/sec.	1.25MB/sec
DATA TRANSFER RATE	2 YEARS	1 YEAR
DRIVE WARRANTY	200,000 Hrs.	Not Spec'd
RELIABILITY	<15 cents	<19 cents

While the data transfers, you can go out and get a cup of coffee. . .in Brazil. (Graphics Express catalog.)

If your entry is used, we'll send you $50 and a *PC Magazine* T-shirt. Send your entries to Abort, Retry, Fail?, *PC Magazine*, One Park Ave., New York, NY 10016-5802 or via e-mail (text items only) to *don_willmott@zd.com*. Winners this issue: Doug Fletcher, Jim Harr, Carol Keating, Mat Keller, Lewis Lorton, Frank Polari, and Farren Williams.

DELL® LATITUDE™ LM P133ST
133MHz PENTIUM® PROCESSOR

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